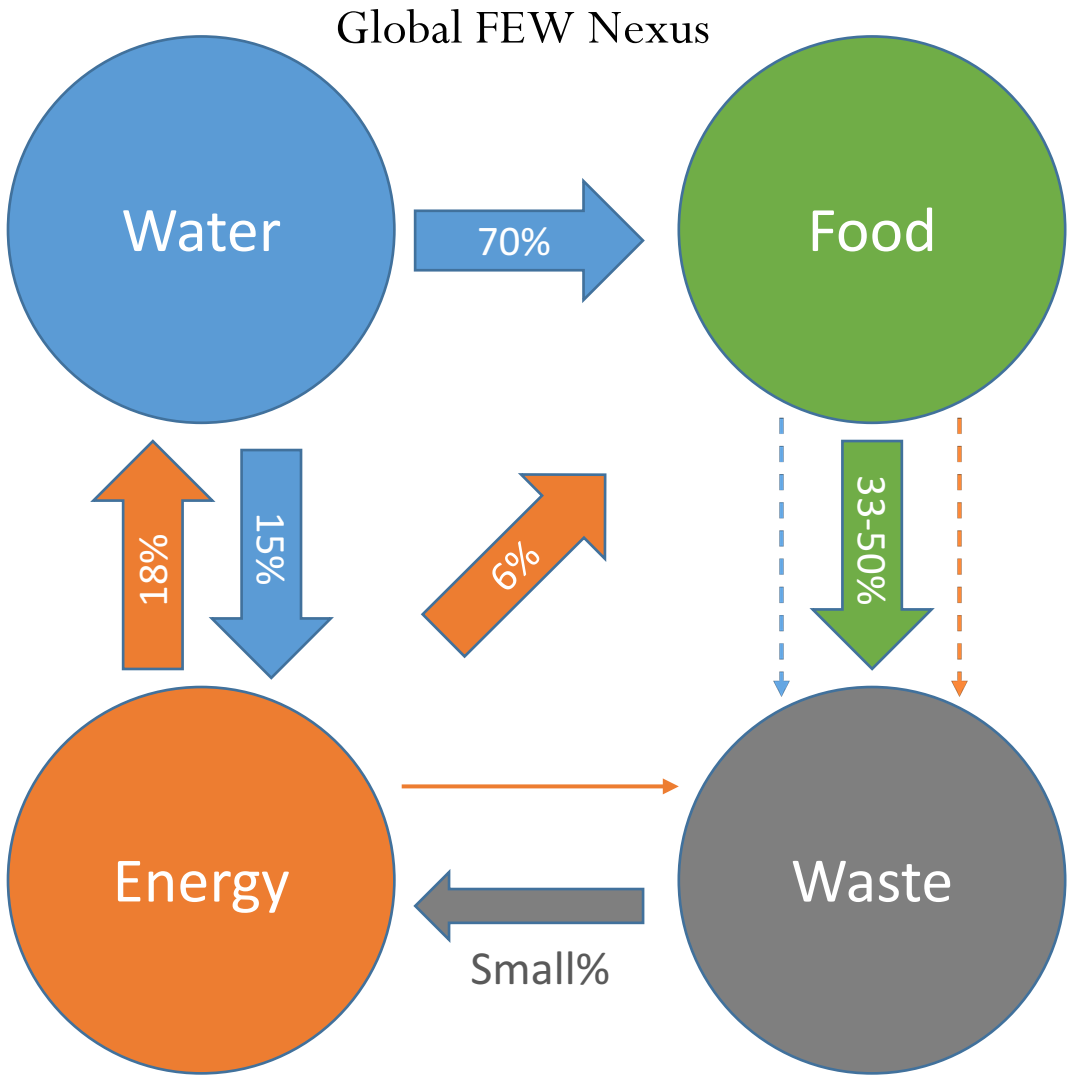
IE GAC Presentation

Food-Energy-Water Nexus

Dr. Edward Spang
Food Science and Technology
Center for Water-Energy Efficiency
May 4, 2017

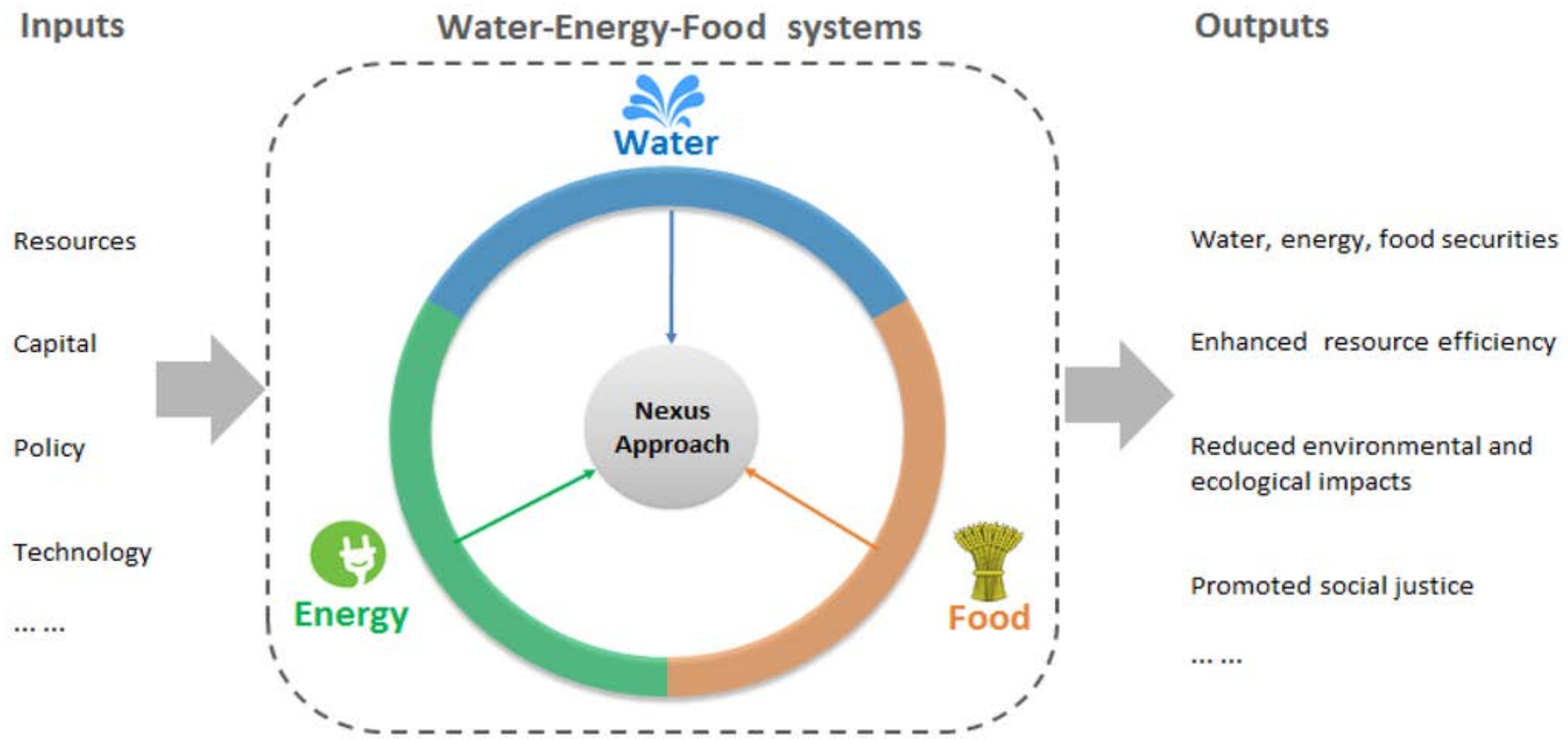
FEW Flows

"Three consumables – water, food and fuel – are perhaps the most important materials imported into urban systems" (Decker et al., 2000).



Adapted from Machell et al. 2015

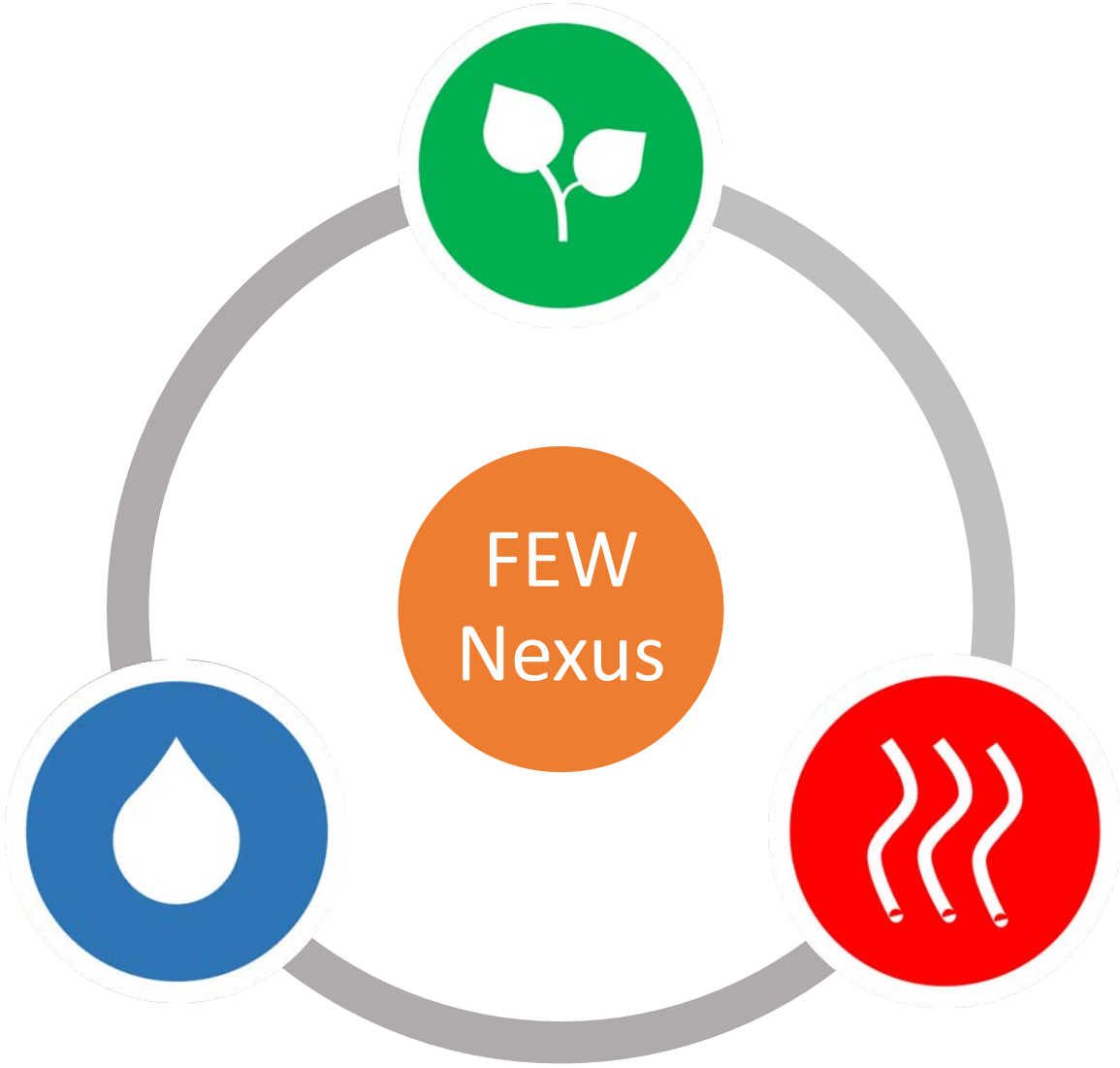
FEW Opportunities & Challenges



Chang et al. 2016

FEW Nexus

- Progression of research
  - Water for energy
  - Energy for water
  - Water-Energy-Food
  - Food Loss and Waste



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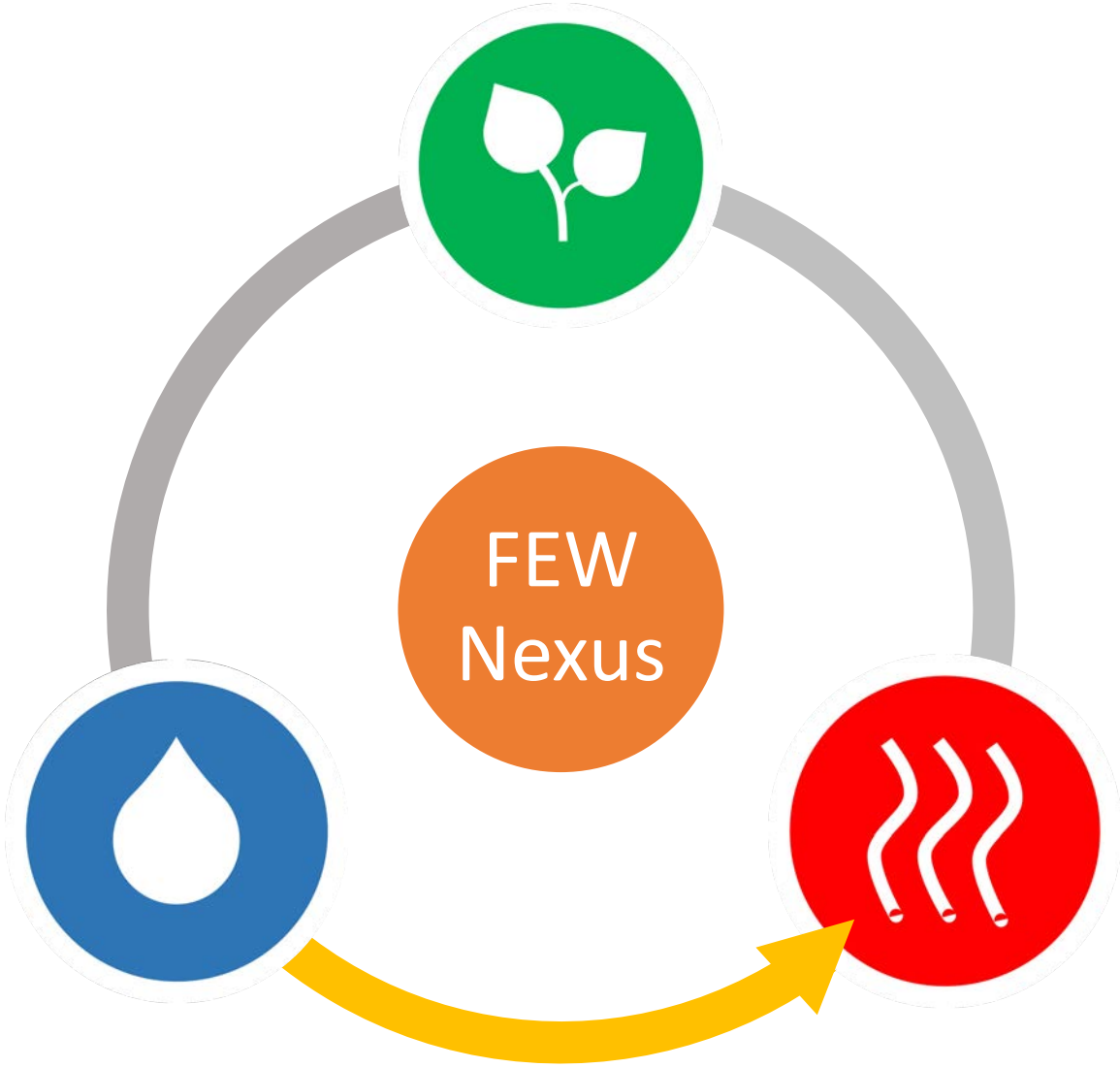
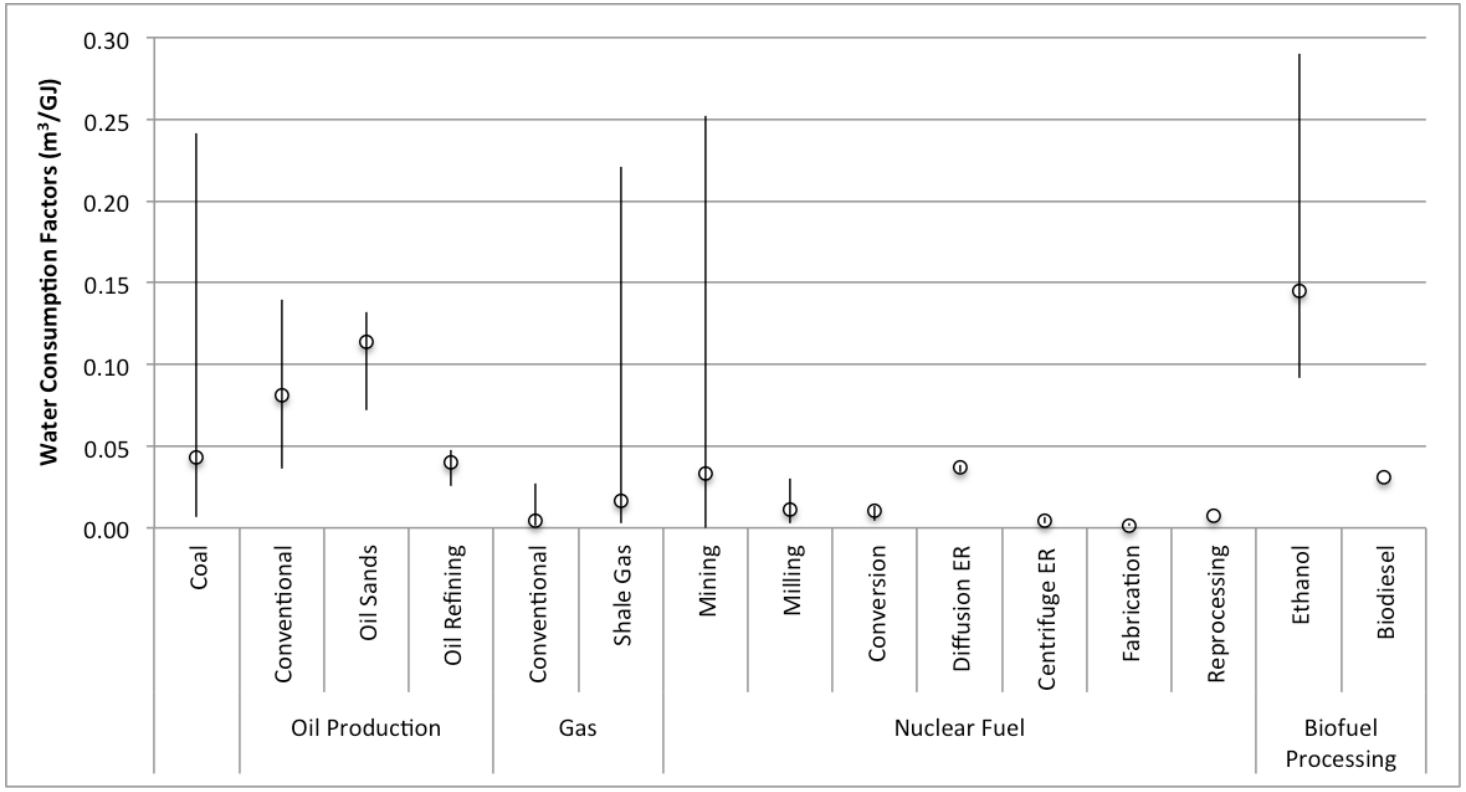


Water for Energy

- Fuel Production
  - Mining and extraction
  - Cultivation of biomass
  - Refining



Wide variation in water intensity within and between energy categories

Spang et al. 2014

Water for Energy

- Fuel Production
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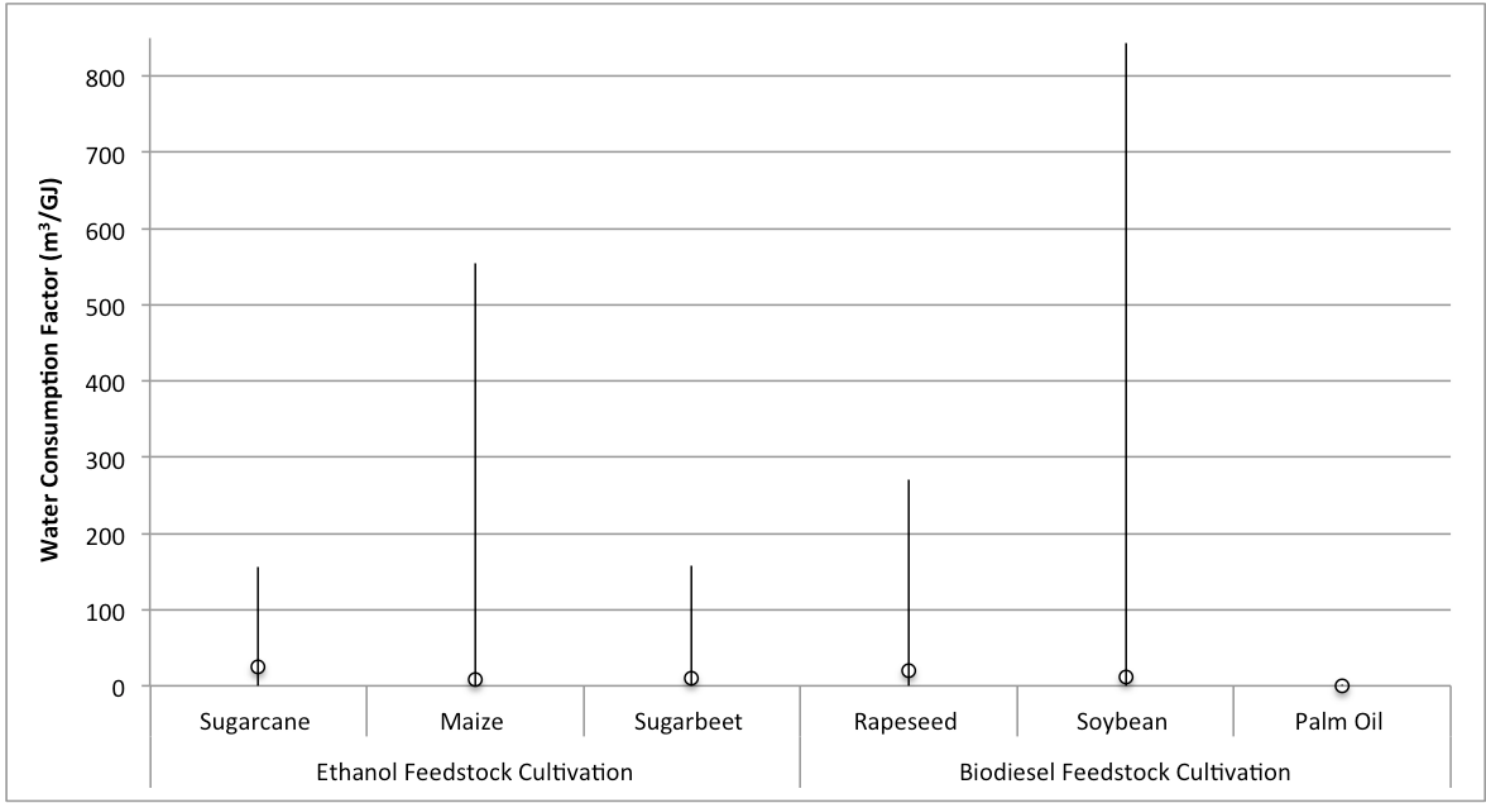
  - **Cultivation of biomass**
  - Refining

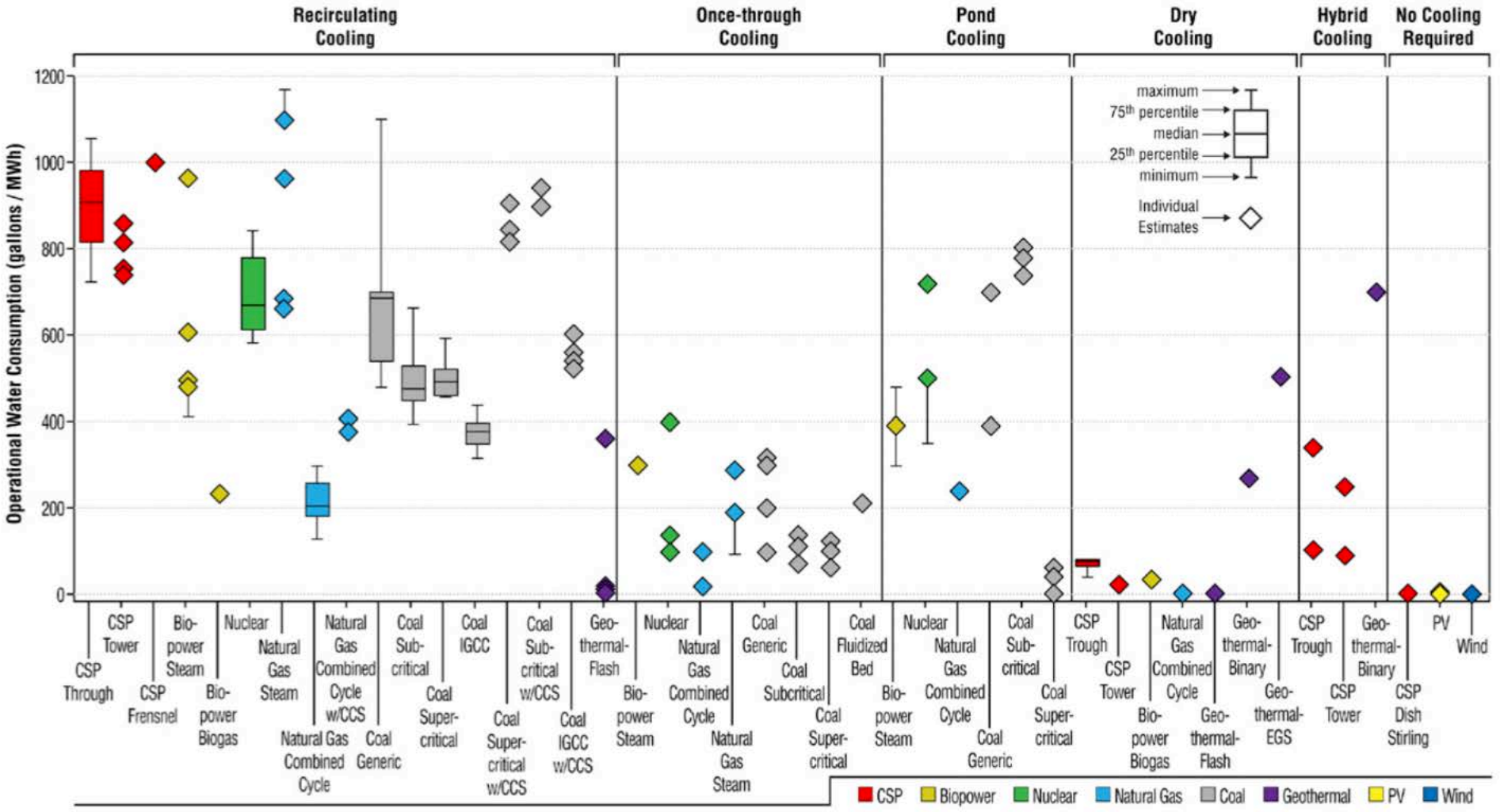


Water use for biofuel feedstock cultivation is 2-3 orders of magnitude greater than for other fuels

Spang et al. 2014

Water Consumption for Electricity

Again, wide variation in water intensity within and between categories

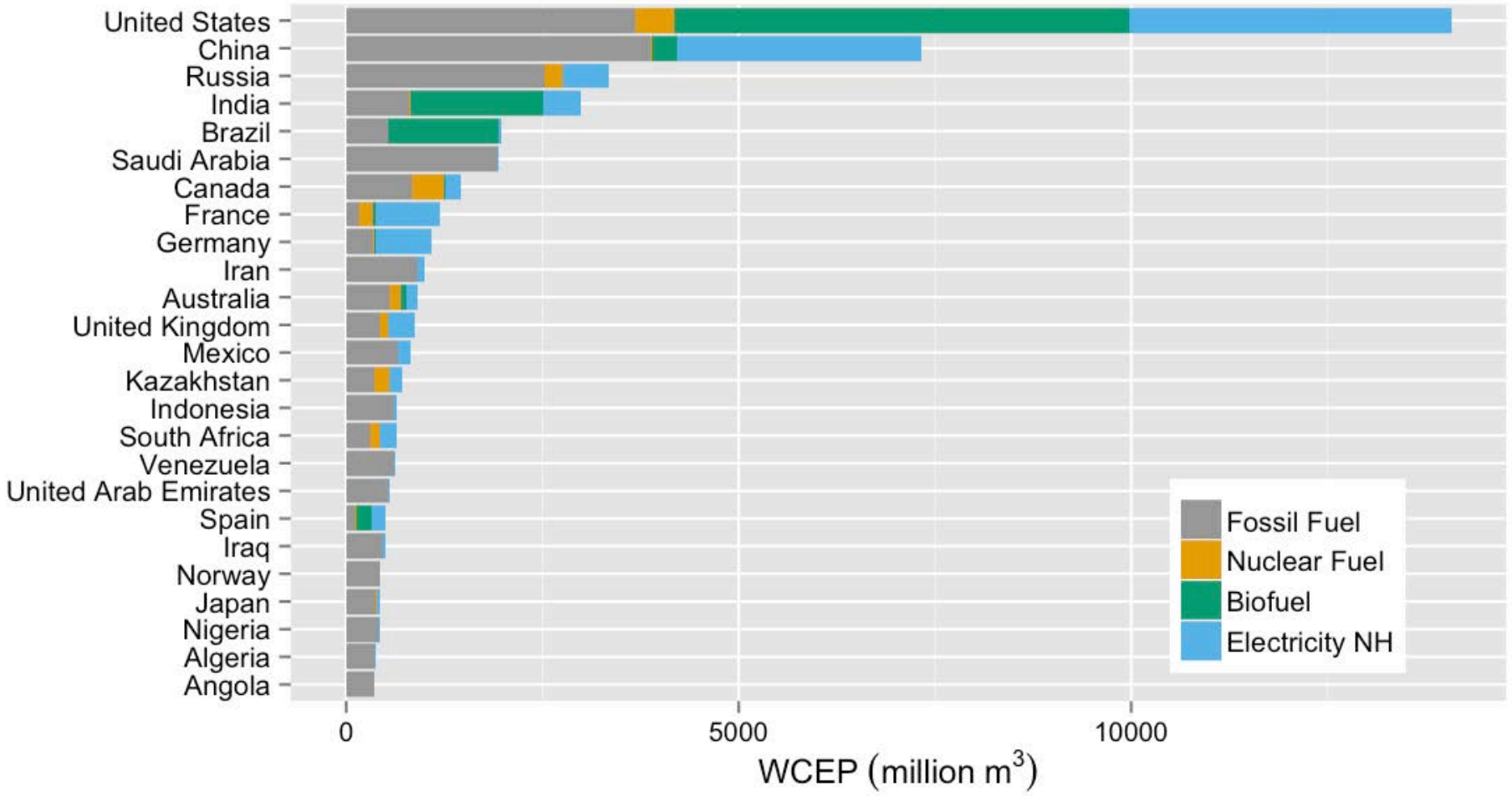


Note: minimal water use for solar PV and wind

Macknick et al. 2012

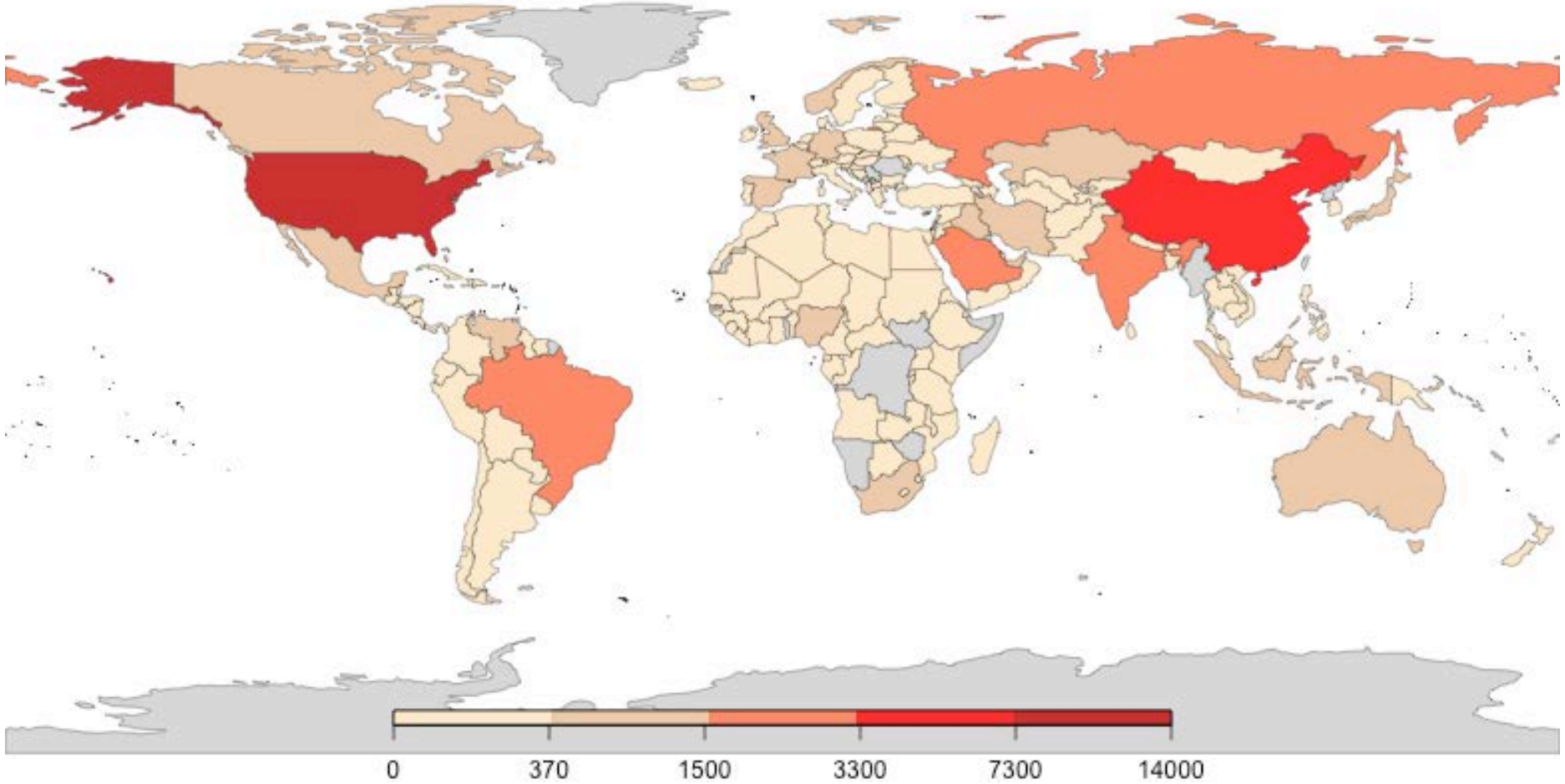
Water for Energy: WCEP

- Consistent indicator
- 4 energy categories
- 37 energy processes
- 158 countries
- Extensive indicator



Spang et al. 2014

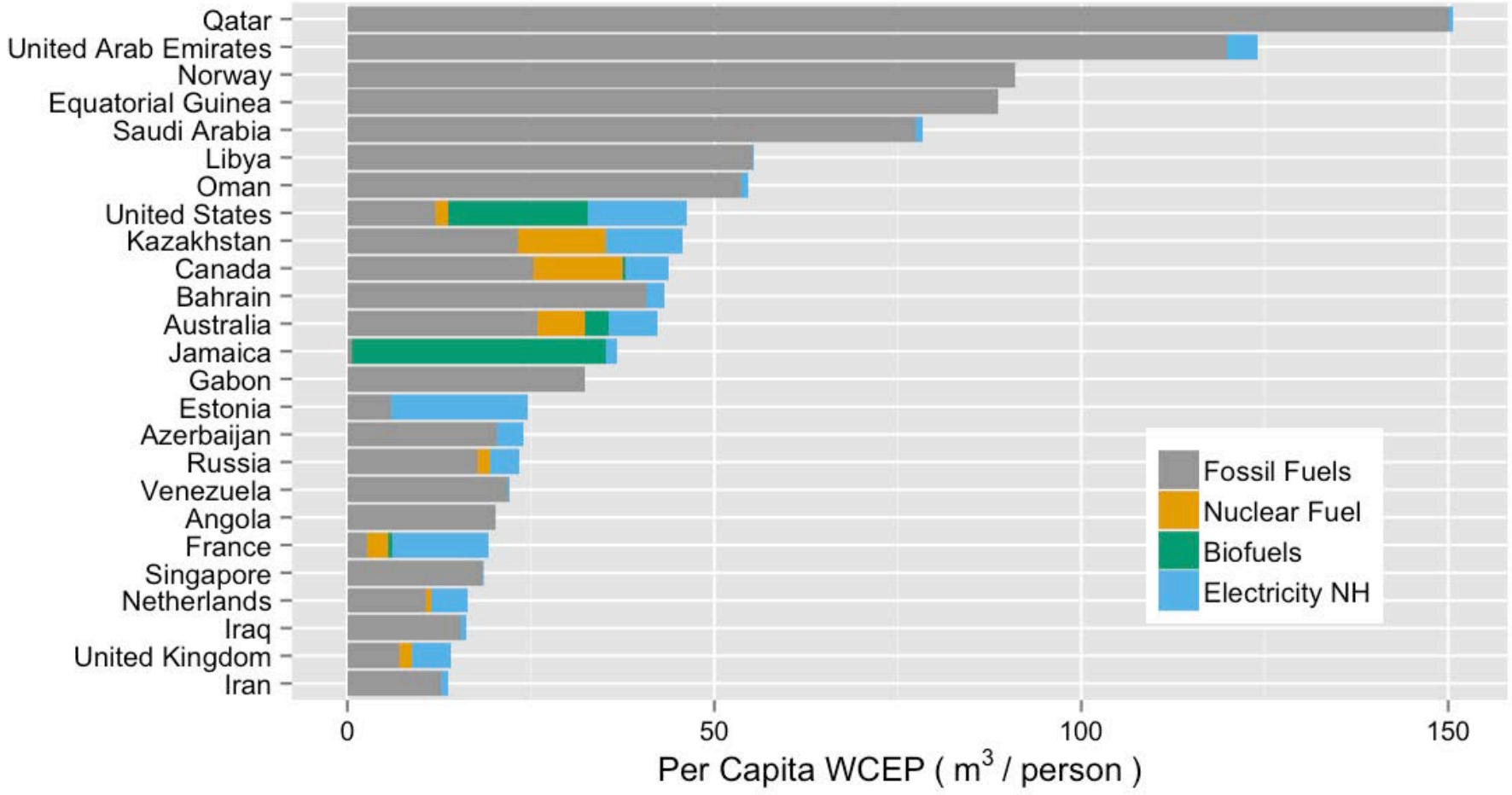
Water for Energy: WCEP



Spang et al. 2014

Water for Energy: WCEP

- Intensive metrics:
  - Per Capita
  - Per Unit GDP
  - Per Unit Energy
  - Per Unit Water



The denominator matters!

Spang et al. 2014

FEW Nexus

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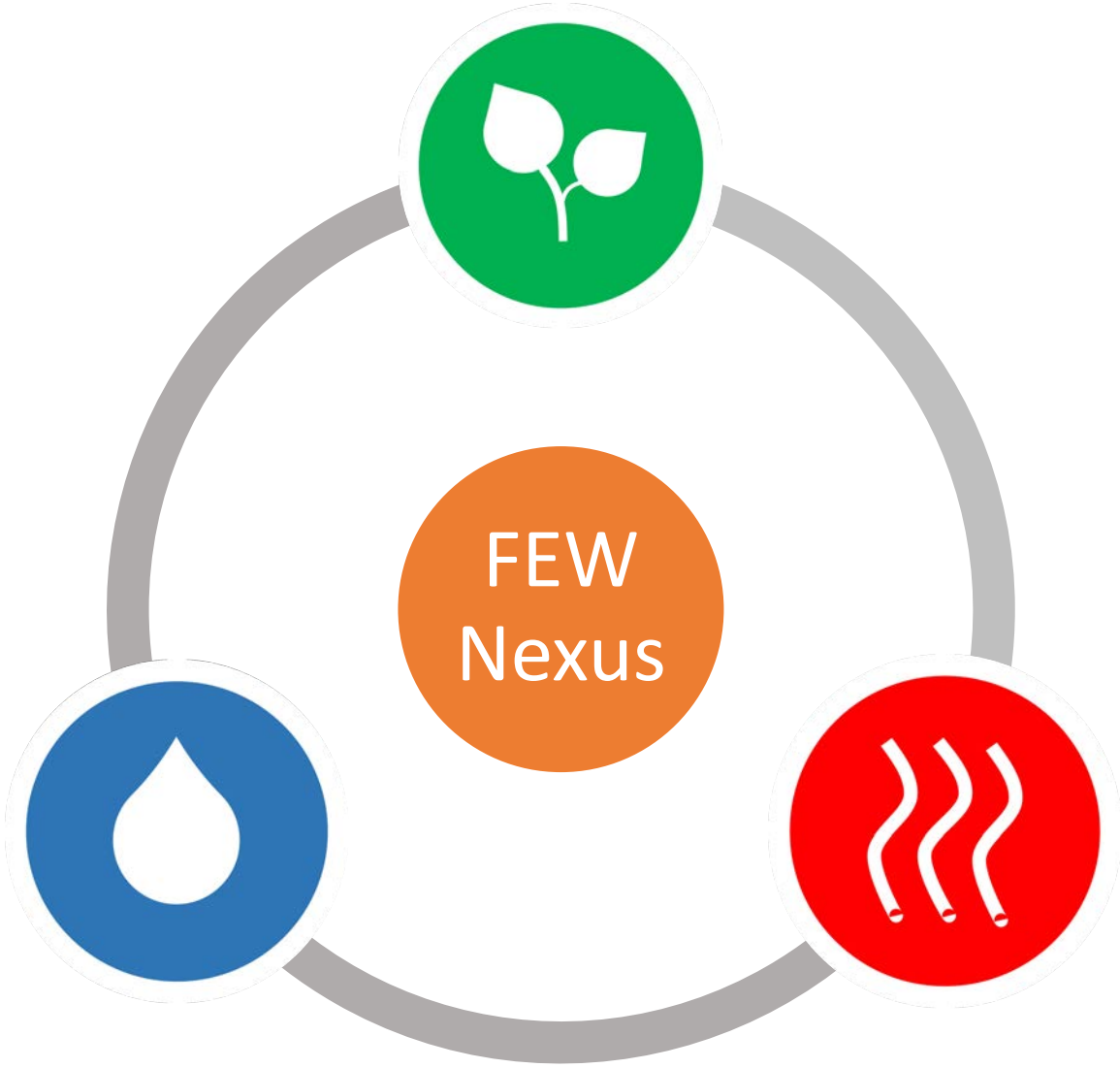

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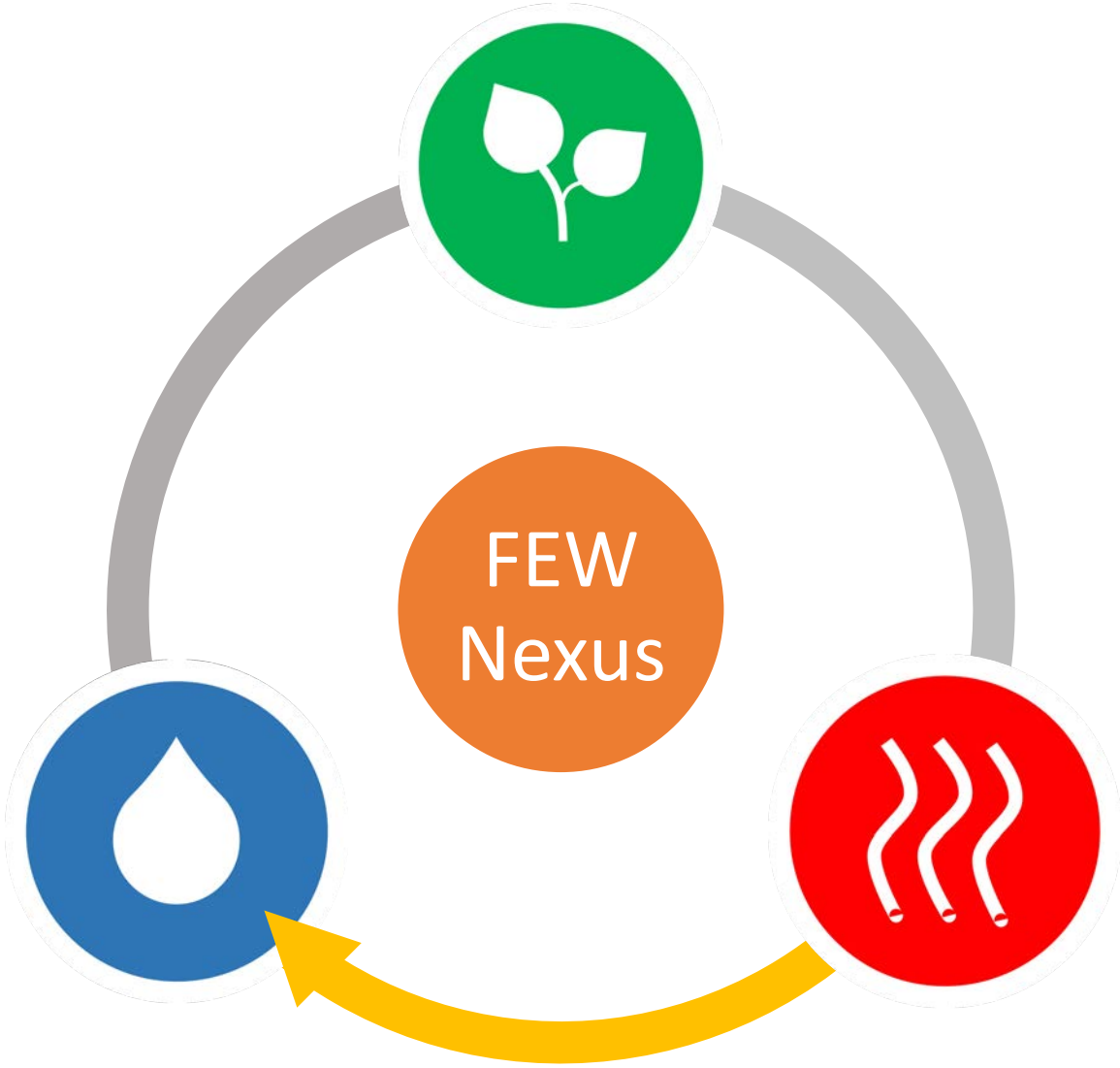
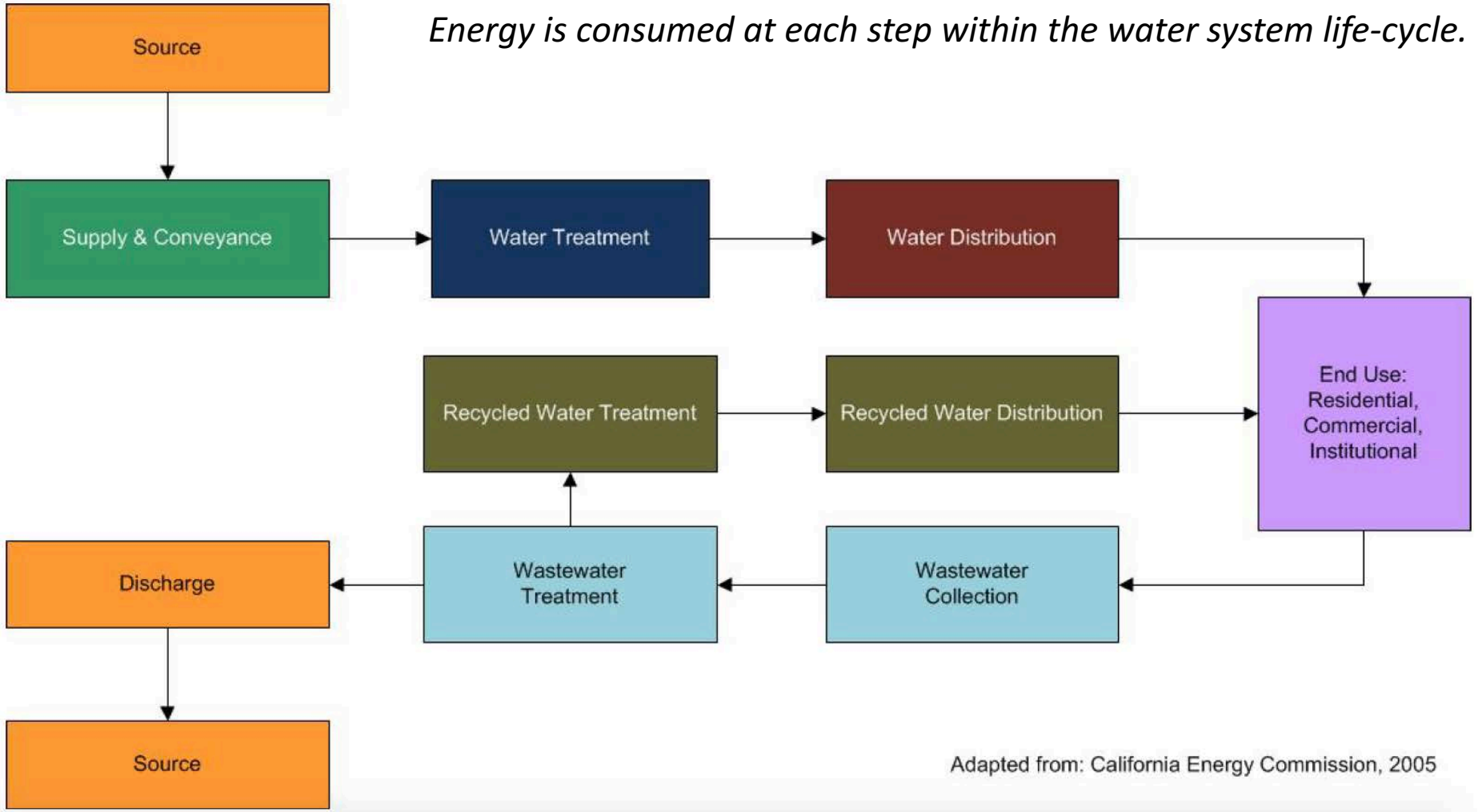


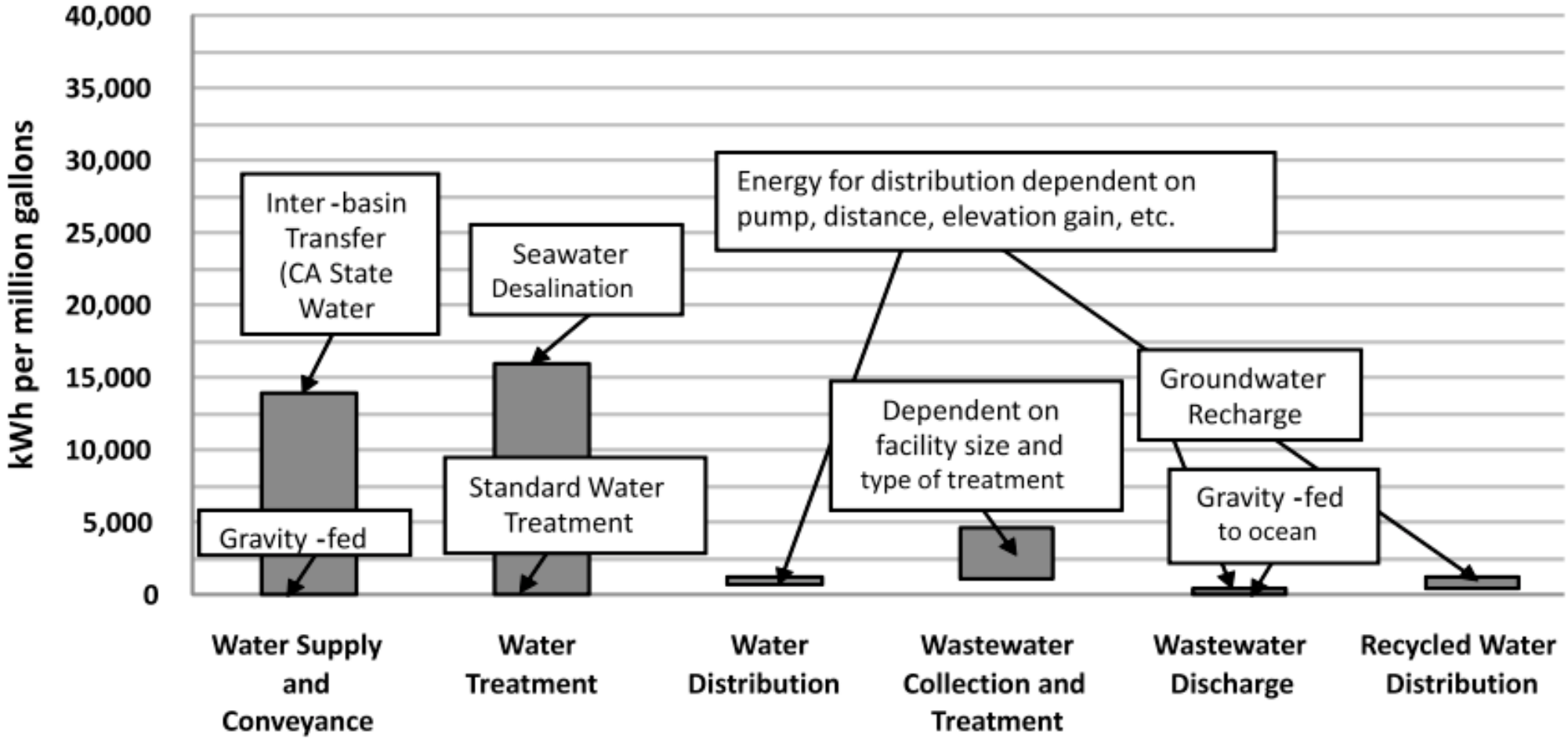
Energy for Water

Energy is consumed at each step within the water system life-cycle.



Adapted from: California Energy Commission, 2005

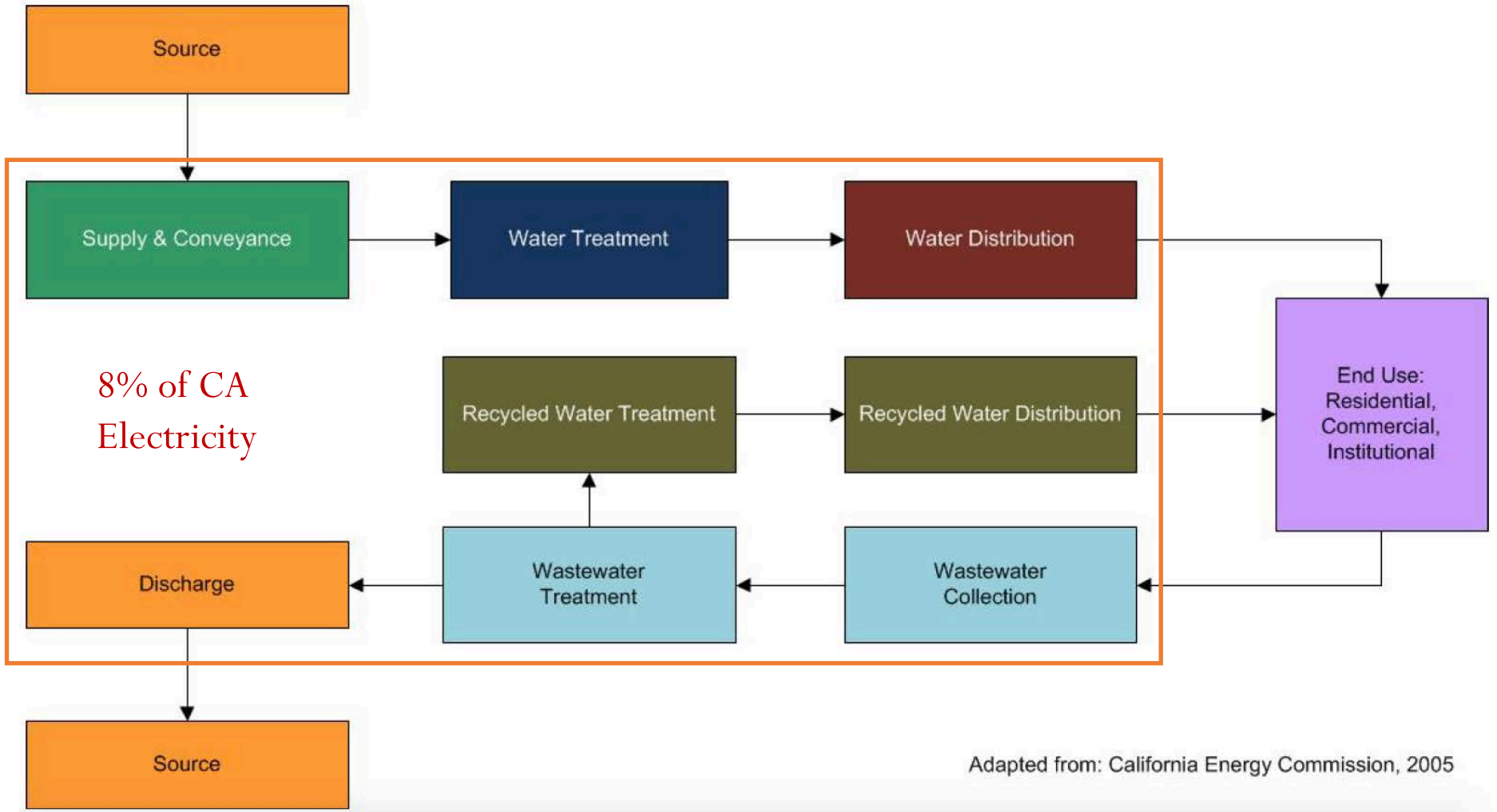
Energy for Water: Intensive



Wide variation in energy intensity within and between water process categories.

Sanders and Webber, 2012

Energy for Water: California

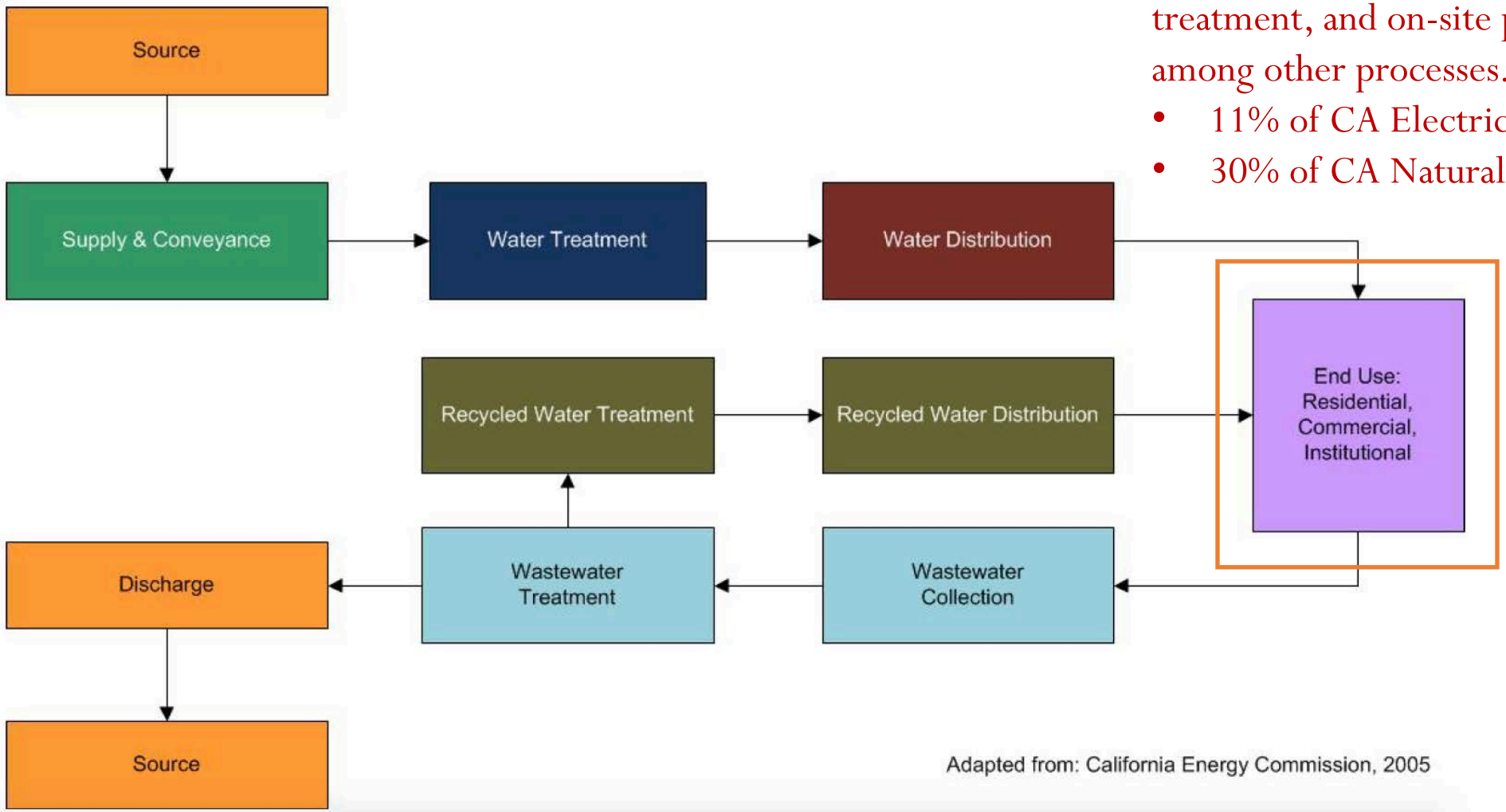


Adapted from: California Energy Commission, 2005

Energy for Water: California

Includes heating, additional treatment, and on-site pumping, among other processes.

- 11% of CA Electricity
- 30% of CA Natural Gas



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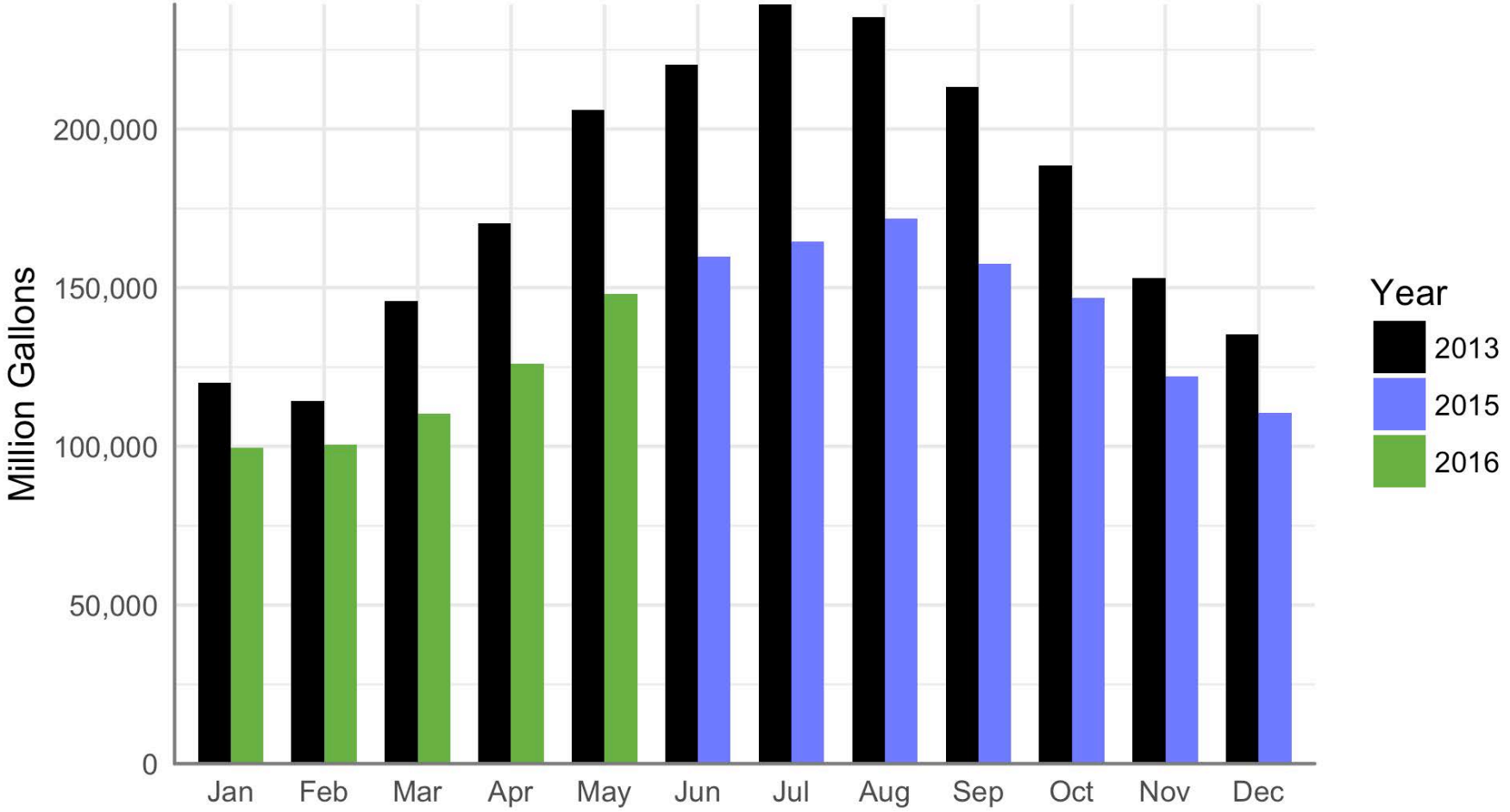
Energy for Water: State Scale

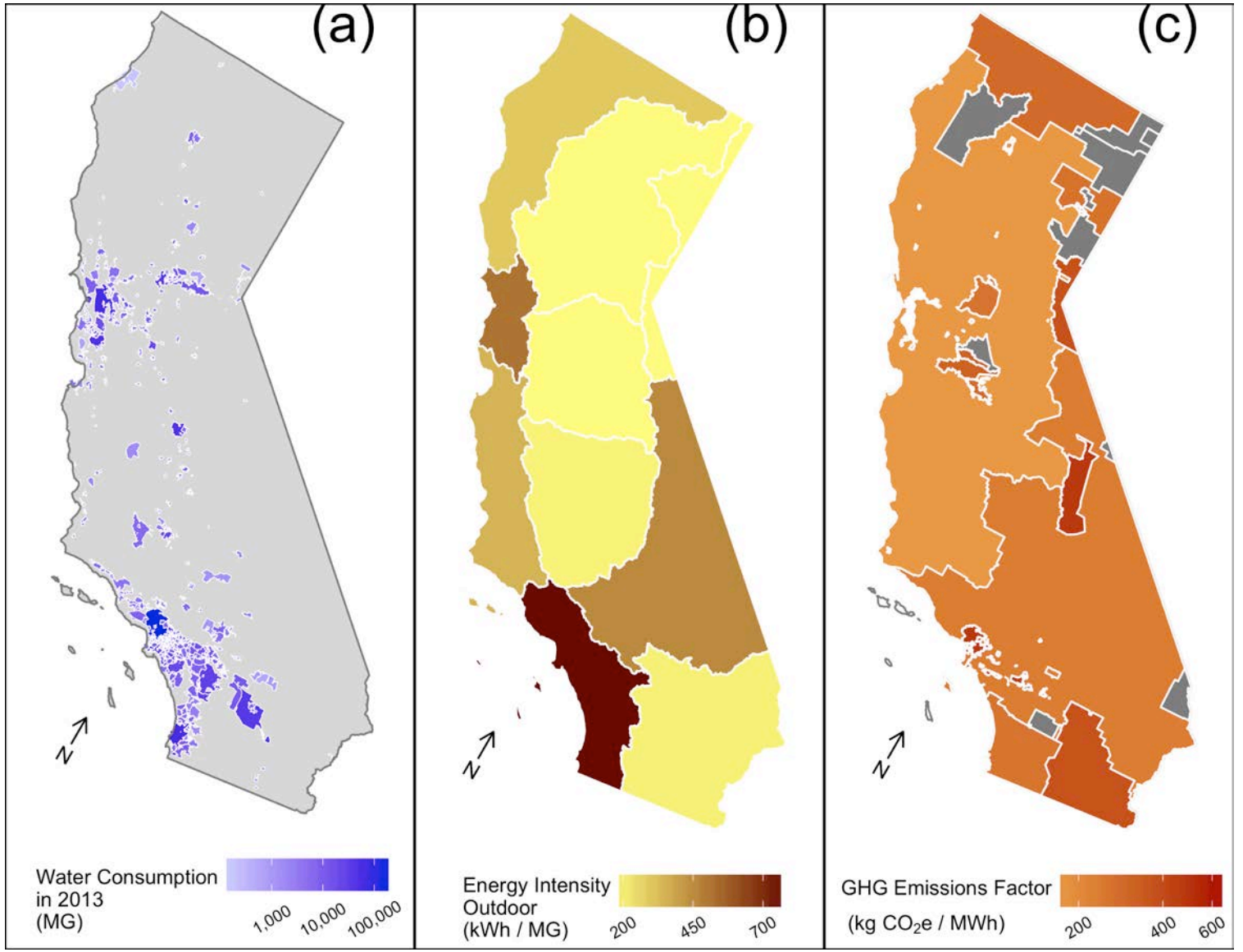
Energy for Water: California

- CA urban water conservation mandate
- 25% reduction in urban water use
- How much energy and GHG savings?



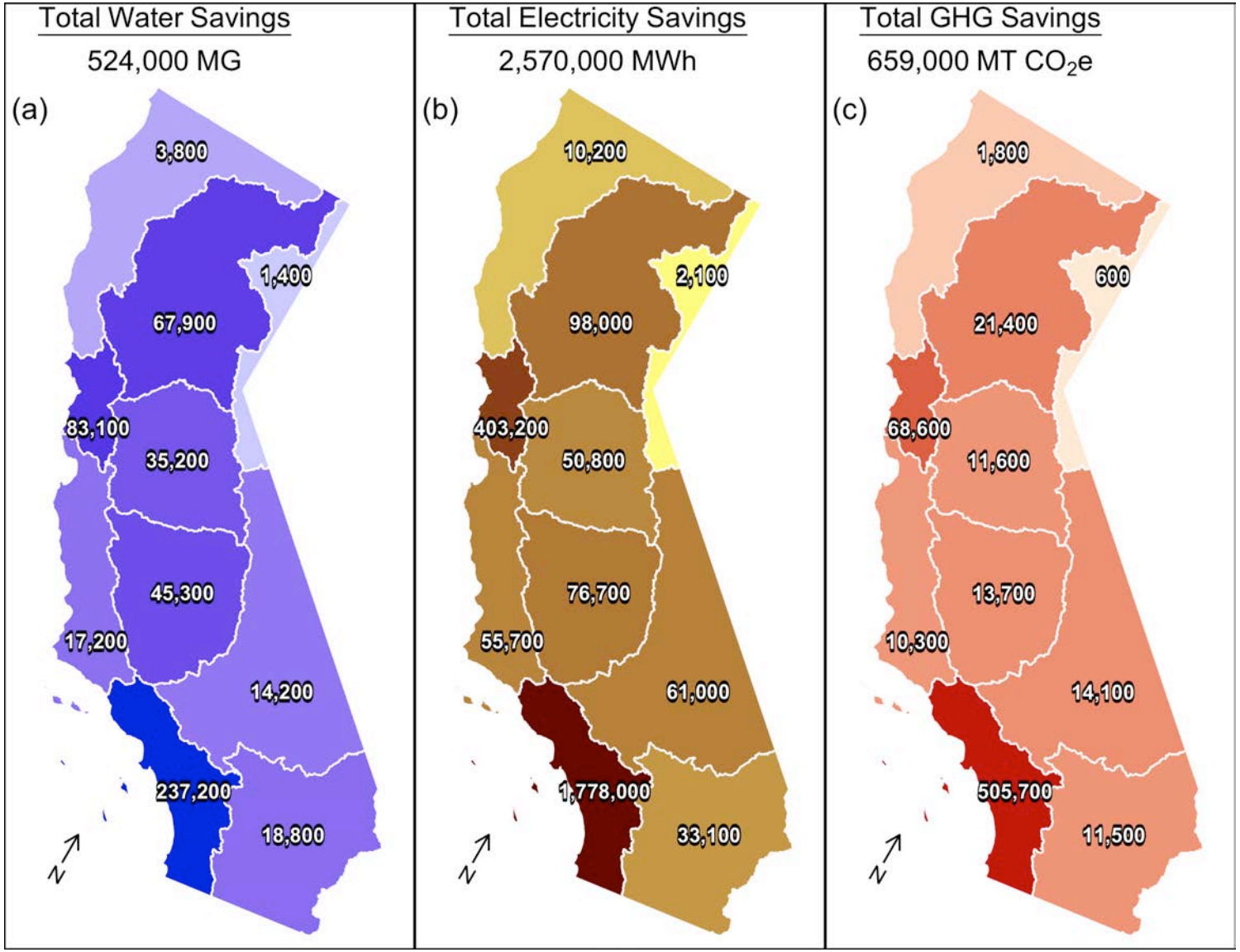
Energy for Water: California

- Spatial Distribution:
  - Water use
  - Energy intensity
  - GHG emissions



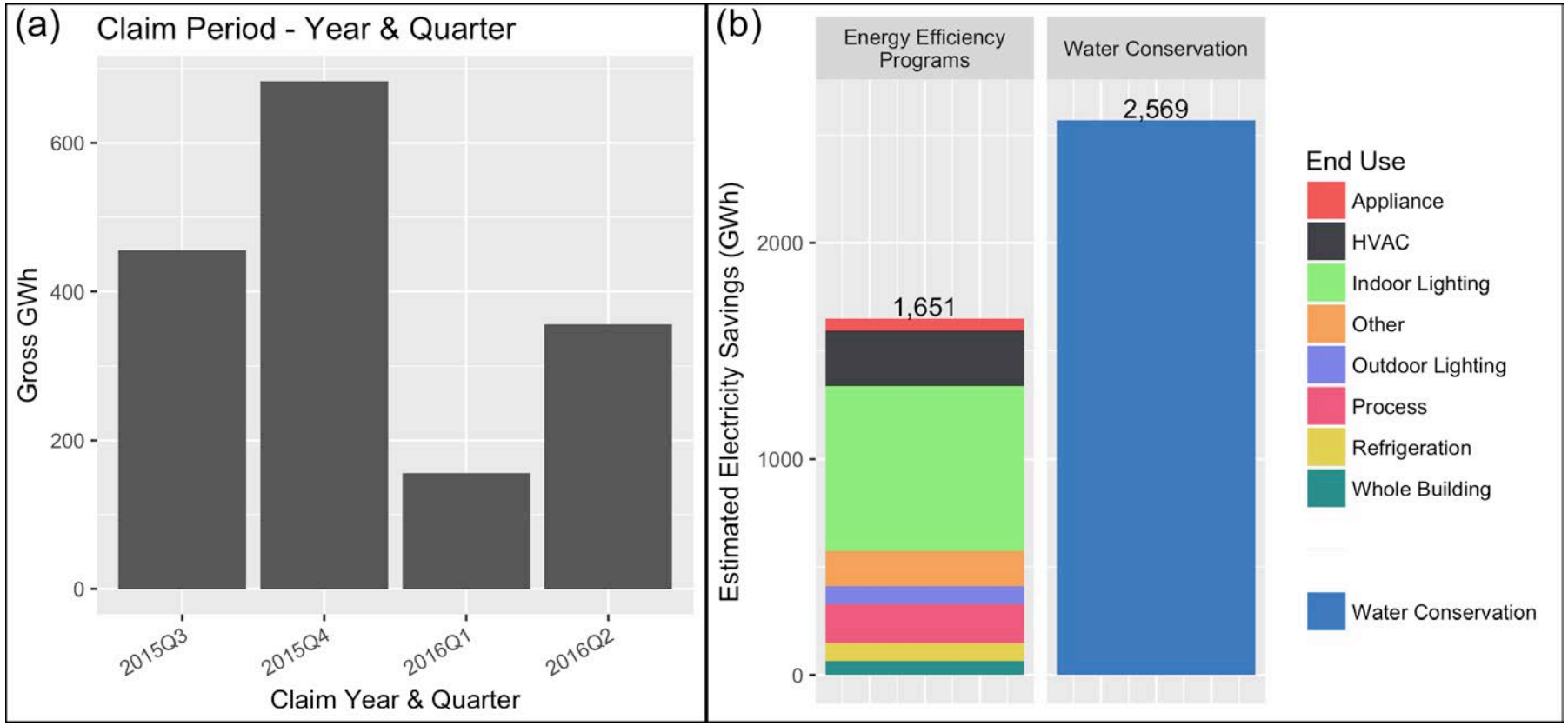
Energy for Water: California

- Integrated geography of water-electricity-GHG savings
- South Coast hydrologic zone dominates water savings and linked energy/GHG savings



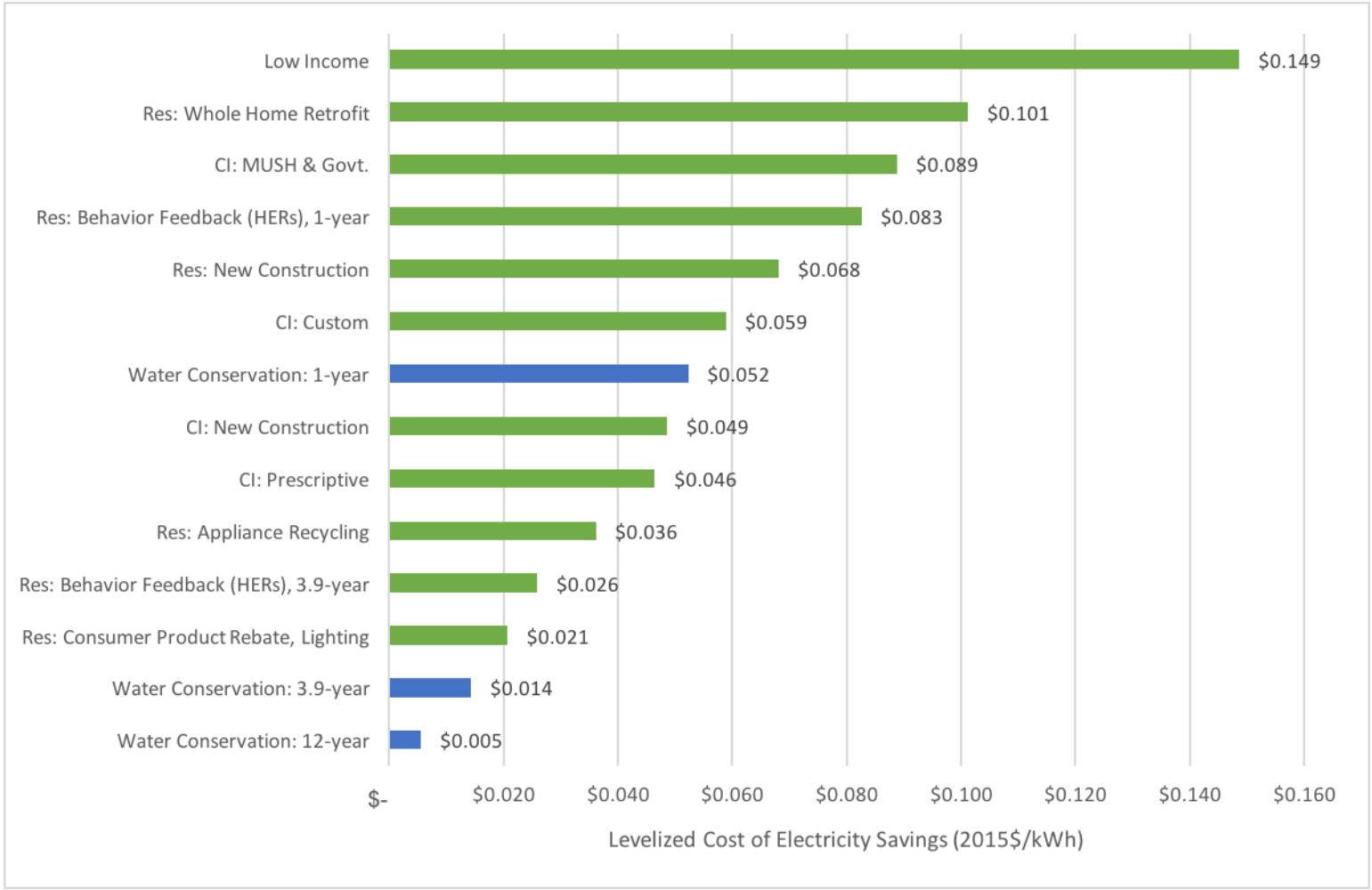
Energy for Water: California

- More electricity saved through water conservation than energy efficiency programs implemented over the same time period



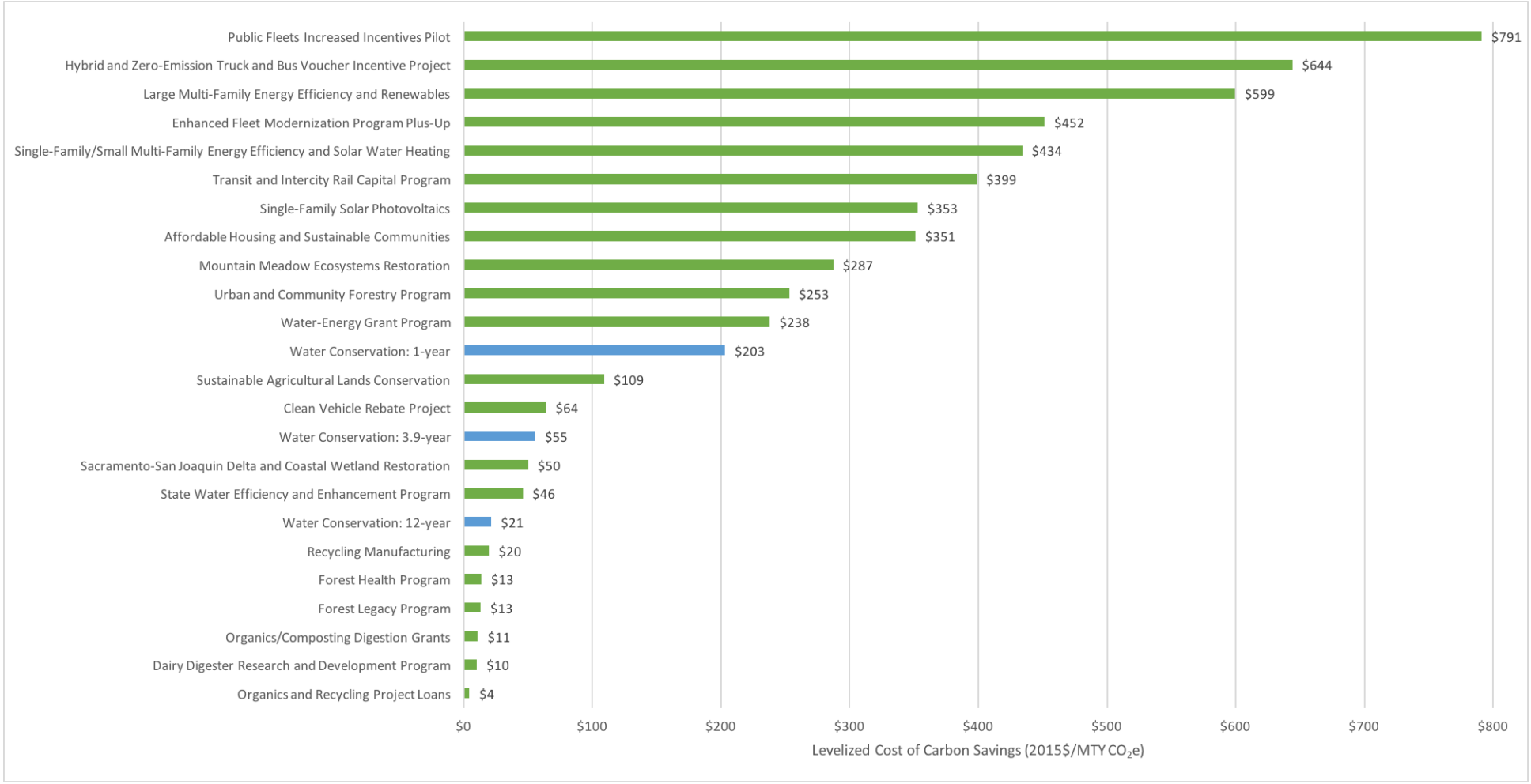
Energy for Water: California

- Cost of electricity savings achieved through water conservation independently competitive with EE programs



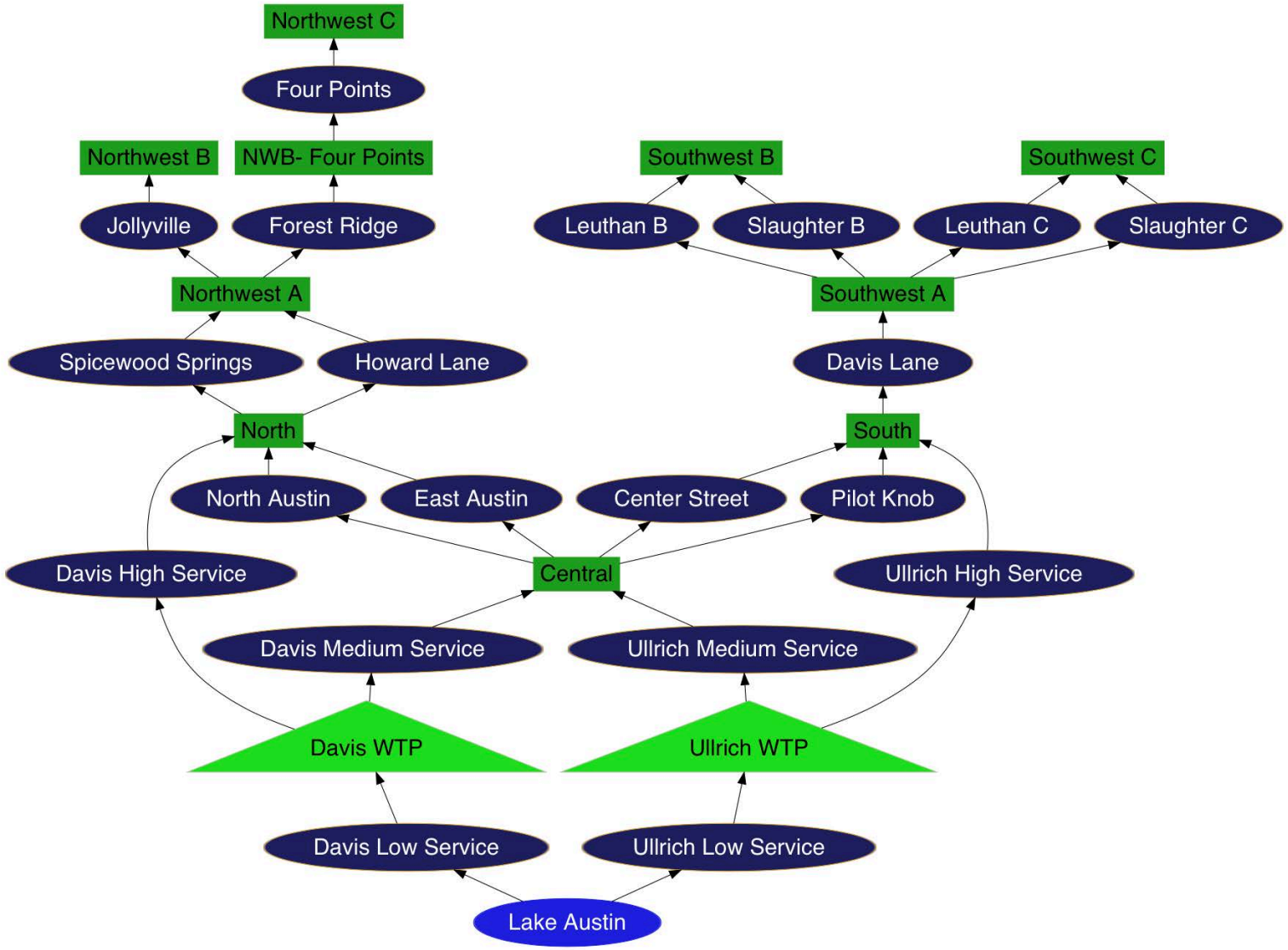
Energy for Water: California

- AND, cost of GHG savings achieved through water conservation independently competitive with GGRF programs



Energy for Water: Utility Scale

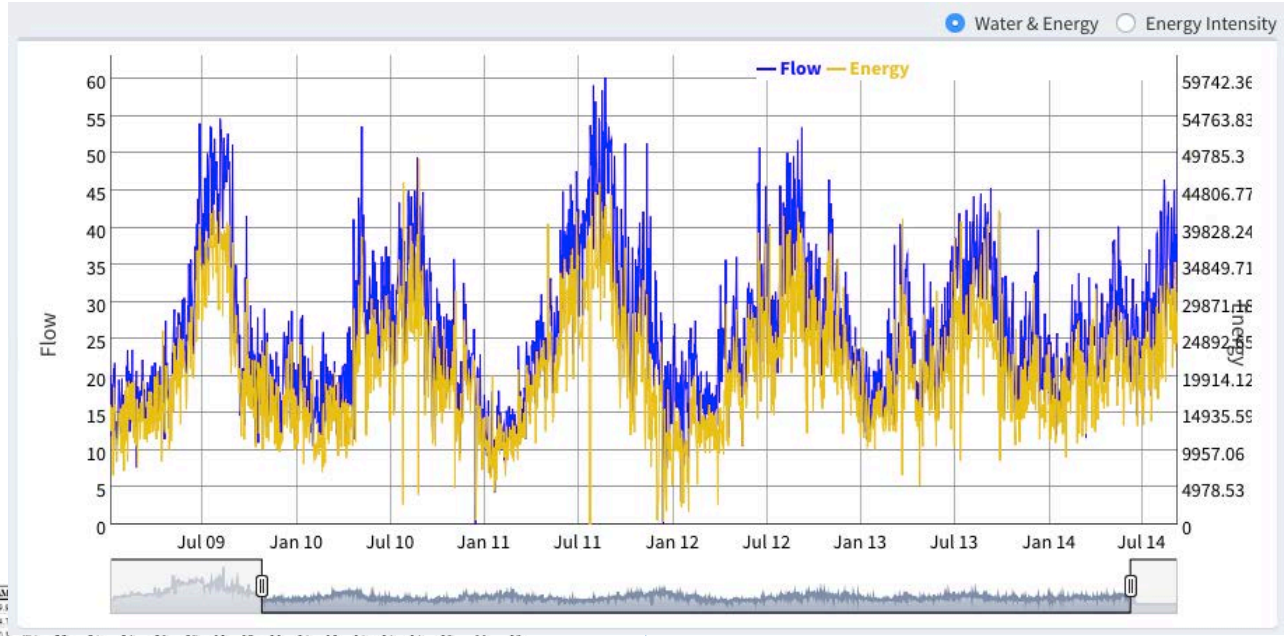
Energy for Water: Austin

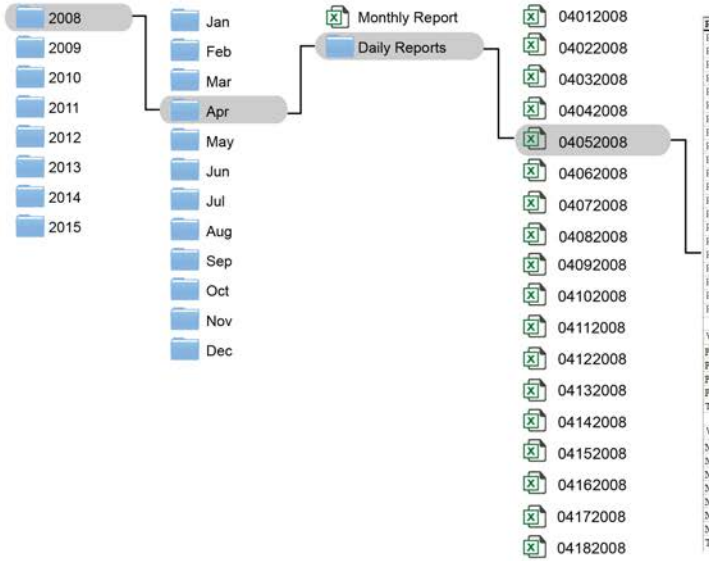


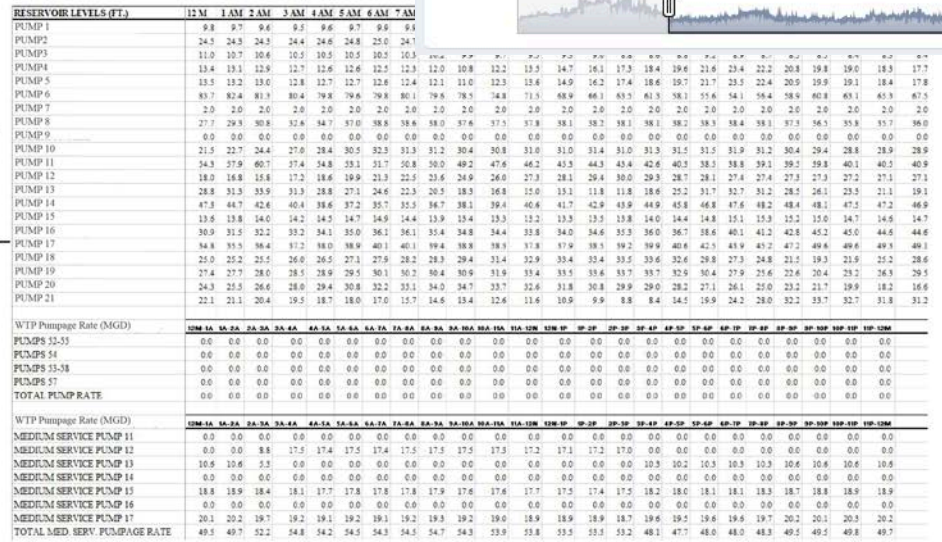
Energy for Water: Austin

Phase 1 Tasks:

- Data Integration
- Energy Intensity Analysis
- Web-based platform







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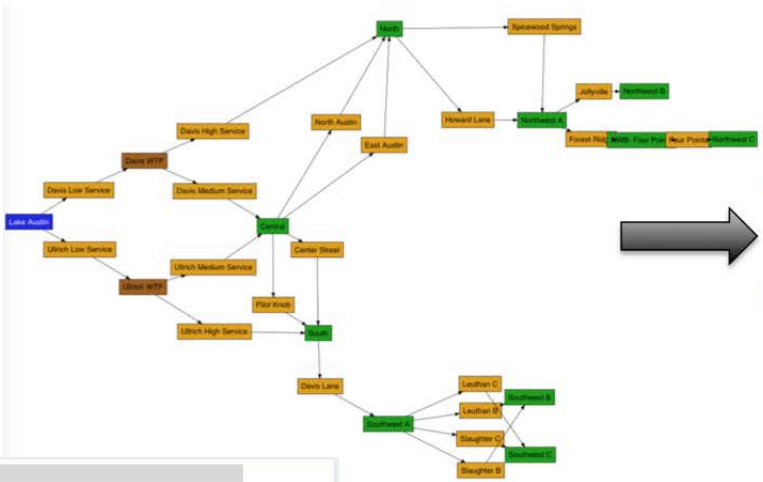

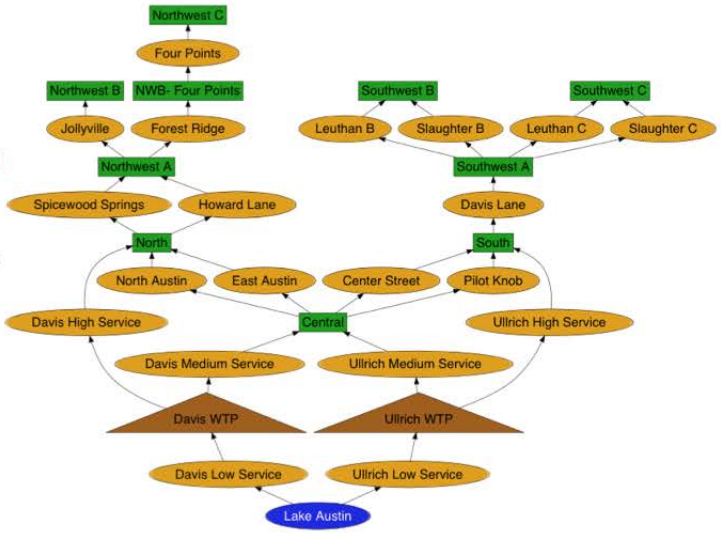

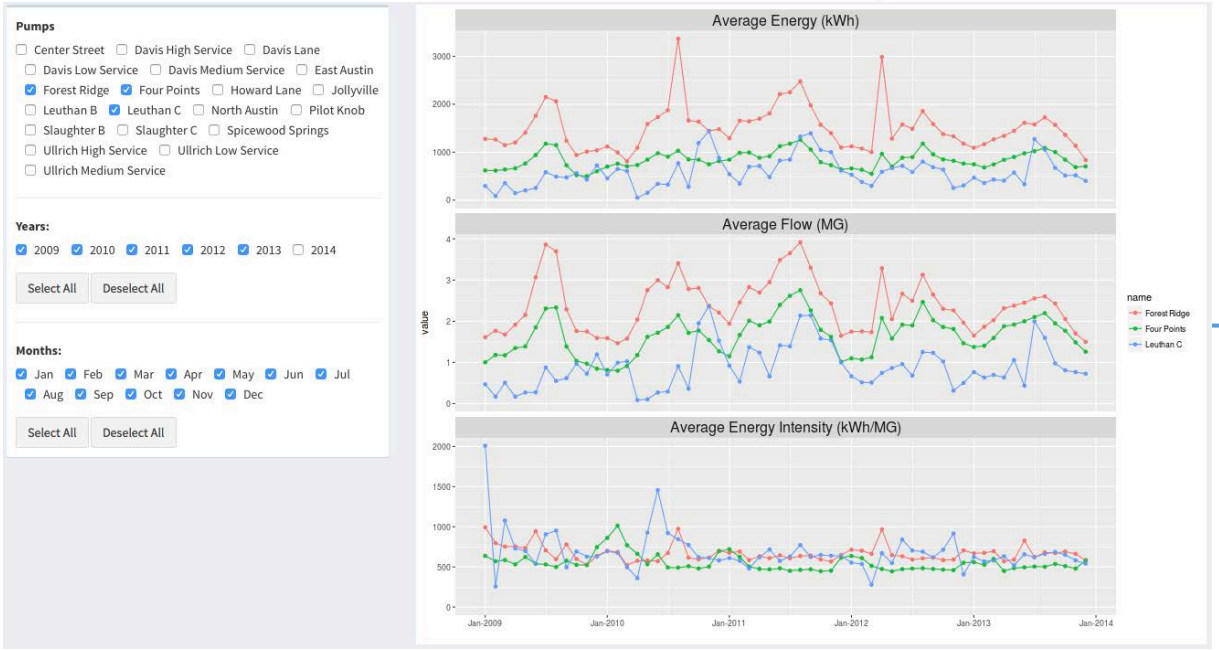

Energy for Water: Austin

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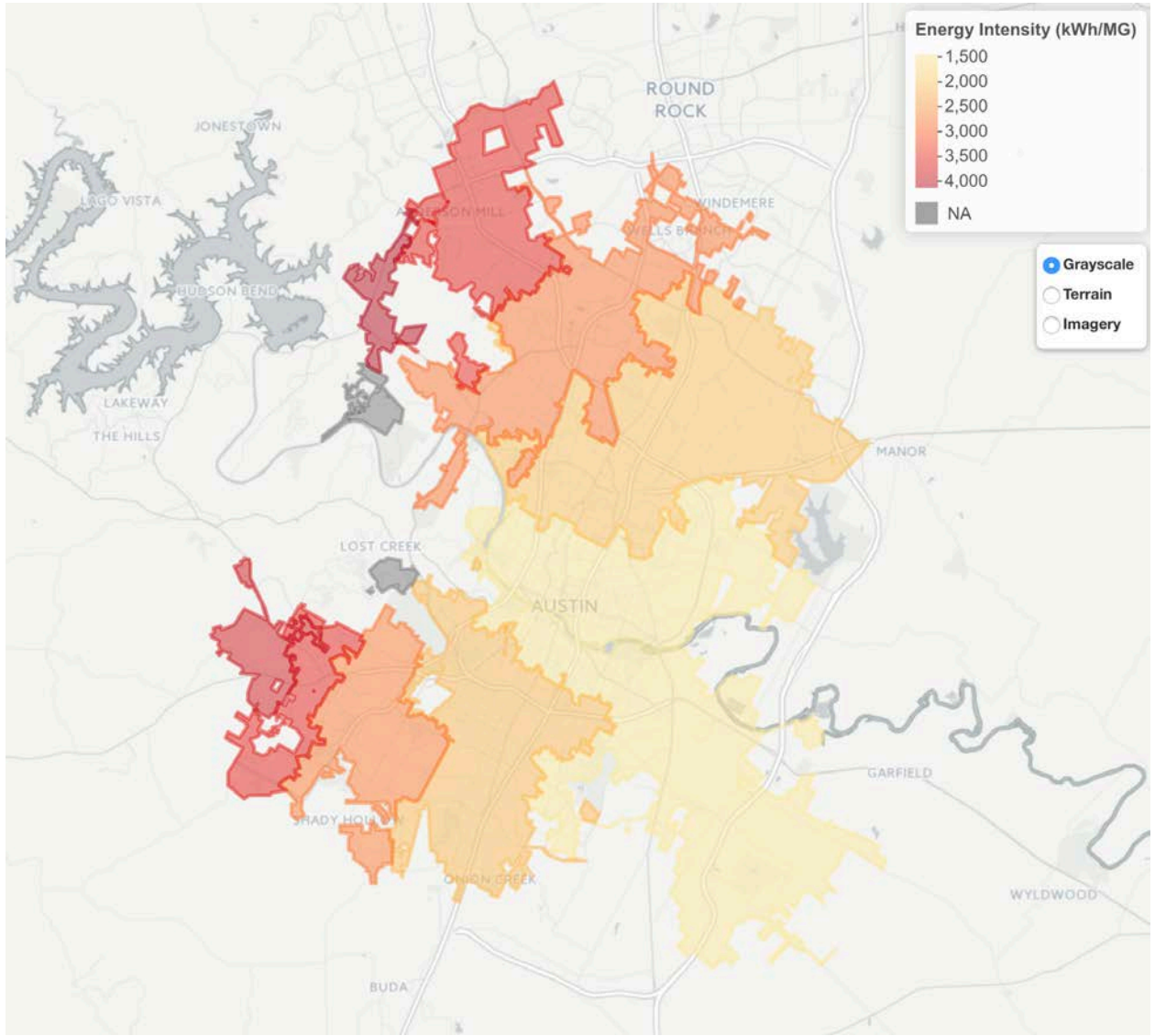


https://cwee.shinyapps.io/Austin/

Energy for Water: Austin

- Integration of customer use data into dashboard
- Model water, energy, GHG*, and cost savings

*Assuming 1.1 lbs CO2e/kWh for Austin Energy grid and included for illustrative purposes knowing that AW is 100% renewable with wind

Energy for Water: Austin

- Explore conservation scenarios
  - By customer type

Energy for Water: Austin

- Explore conservation scenarios
  - By customer type
  - And by pressure zone

Energy for Water: Household Scale

Water, Energy, and Behavior

- Understanding behavioral communication
  - Benchmarking & norms based communication
  - RCT: Spillover effect of conservation messages?

City Water | WaterInsight Program, 123 Main Street, Anytown, CA 95875

TREATMENT 2
Hot Water Messaging: Usage

Your WaterScore
AUG 1 TO SEP 30, 2015

Nice work, WaterSaver.
Take action to save even more.

SOCIAL
Gallons Per Day (GPD)
14 CCF = 250 GPD

Efficient Neighbors 120 GPD
You 110 GPD
Average Neighbors 170 GPD
hot water | cold water

Highlight hot water here?

YOUR HOME WATER REPORT
THIS IS AN INFORMATIONAL REPORT AND NOT A BILL.

SERVICE ADDRESS: 456 Washington St., Anytown
ACCOUNT NUMBER: 123456789-02

SIGN UP TO GET THIS REPORT VIA EMAIL: citywater.com

Blair Jones
456 Washington St.
Anytown, CA 98765

INFORMATIONAL
Did you know?
The second largest use of energy in a home is for heating water. Save water, energy, and money by reducing hot water use. Follow the tips below and log into your WaterSmart account for more.

MONEY TO MODIFY BEHAVIOR
Get paid to save!
Save XX% of your average household water use over the next 6 months and get paid $XX.

* Hot vs cold water messaging?
* Messaging content?

Water-saving actions just for you
Selected assuming your home has 4 occupants and a gas hot water heater

Log on to correct us!

Potential savings if you:

* Include energy impact?
* Prioritize hot water recommendations?
* Hot vs cold water recommendations

Replace gas tank water heater with tankless gas water heater
- GALLONS PER DAY
115 THERMS PER YEAR
$103 DOLLARS PER YEAR

Decrease your water heater temp to 120°F
- GALLONS PER DAY
73 THERMS PER YEAR
$66 DOLLARS PER YEAR

Reduce shower time by 3 mins
48 GALLONS PER DAY
171 THERMS PER YEAR
$154 DOLLARS PER YEAR

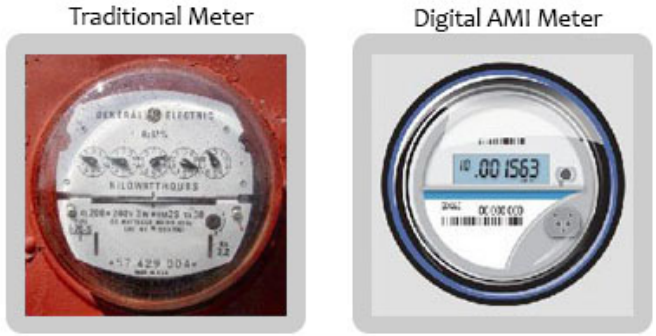
*cost estimates based on Burbank Water & Power and SoCal Gas utility rates

Log On
Take the guesswork out of saving water. See:
•Where you're using the most
•All actions relevant to you
•Step-by-step tips and rebates
citywater.com
Registration Code: XYZYXS
Zip Code: 98765
A free service offered by your water utility and powered by WaterSmart software*

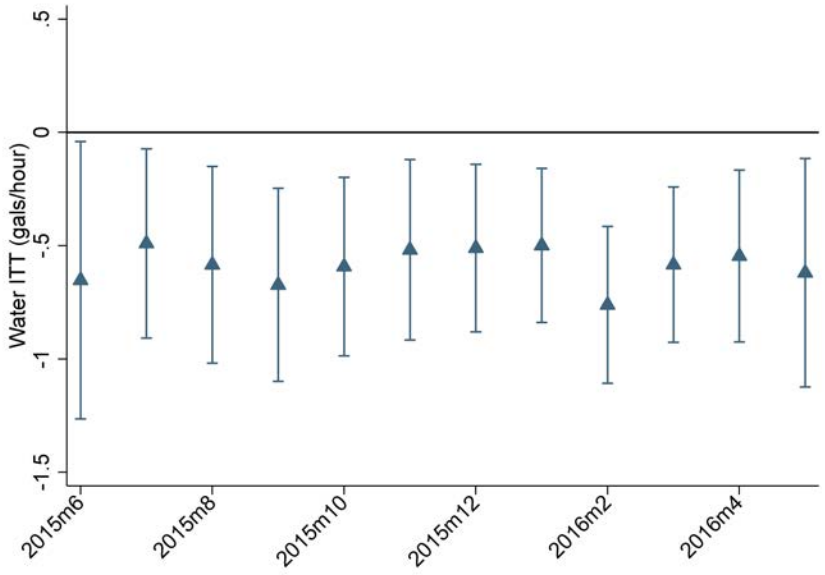
Water, Energy, and Behavior

- Observed savings: 4.6% water; 1.3% electricity
- Challenge: Integration of private data

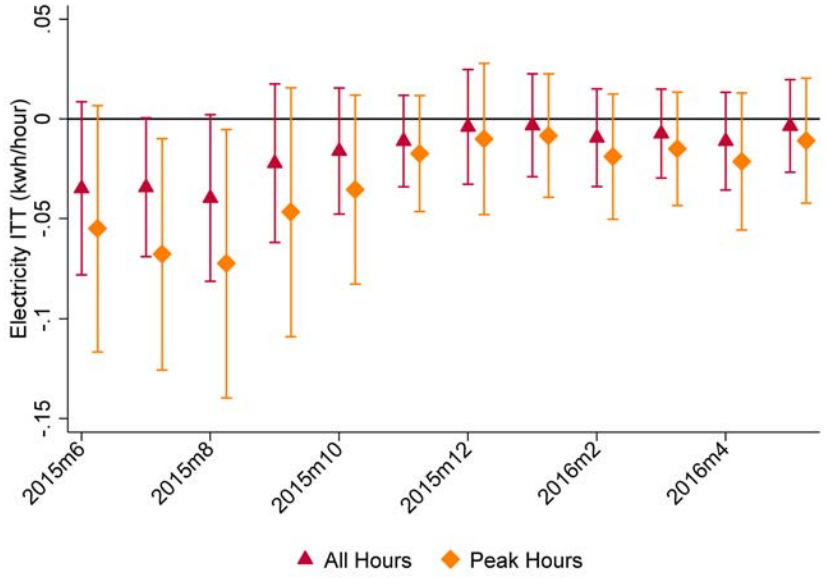
1 read/mo
12 reads/yr



1 read/15m
>35K reads/yr



Water Treatment Effects Over Time



Electricity Treatment Effects Over Time

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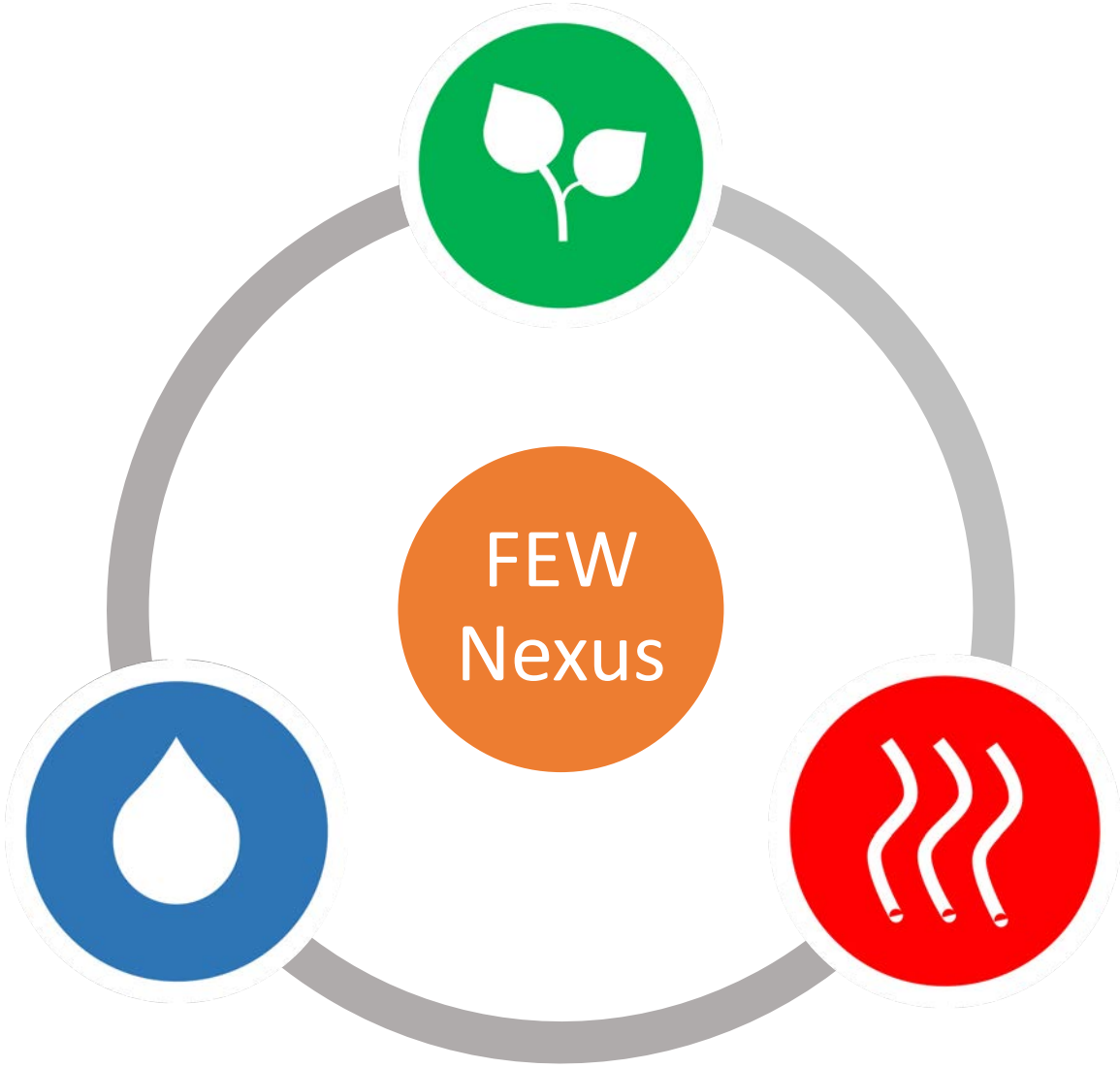

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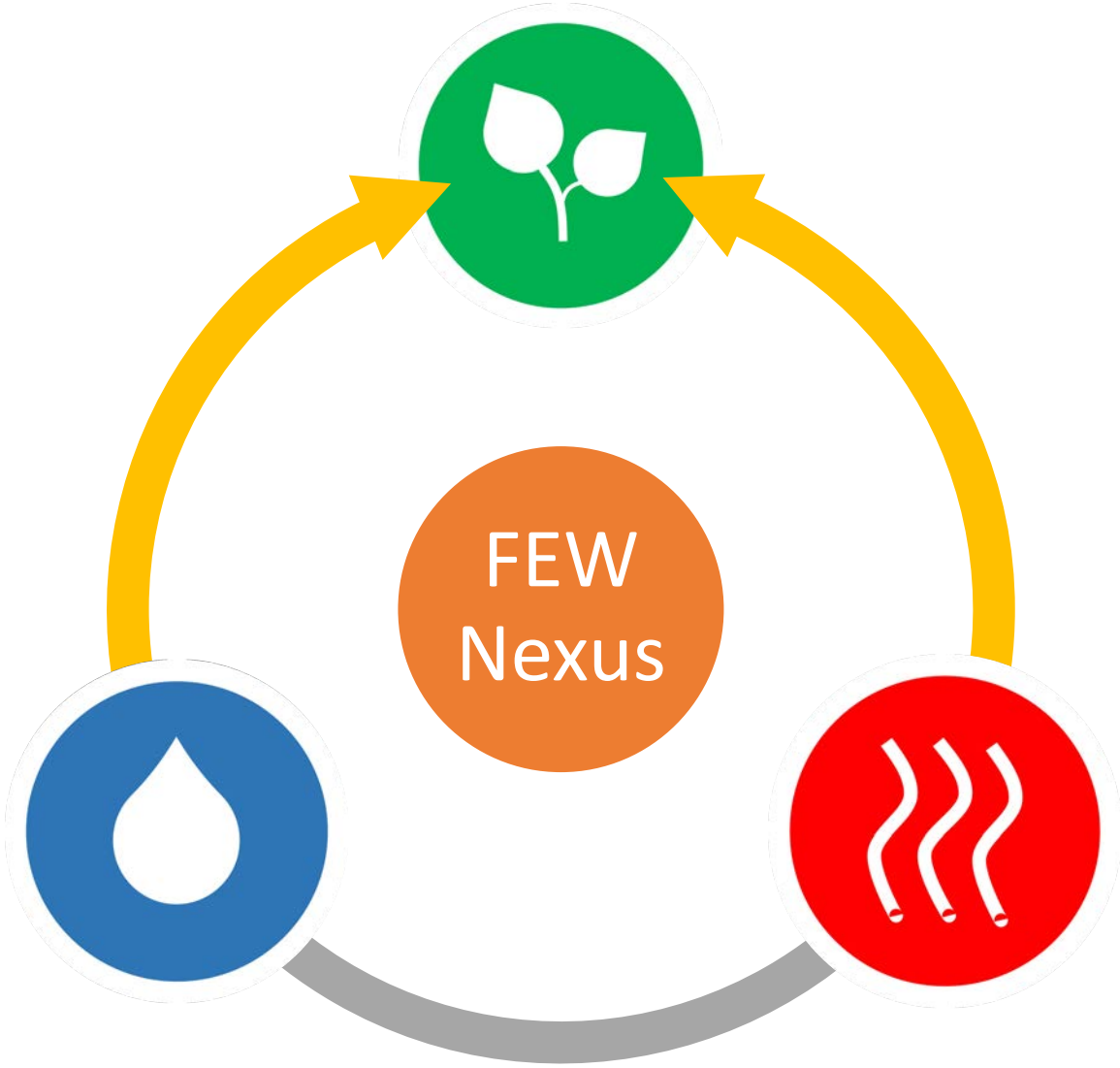
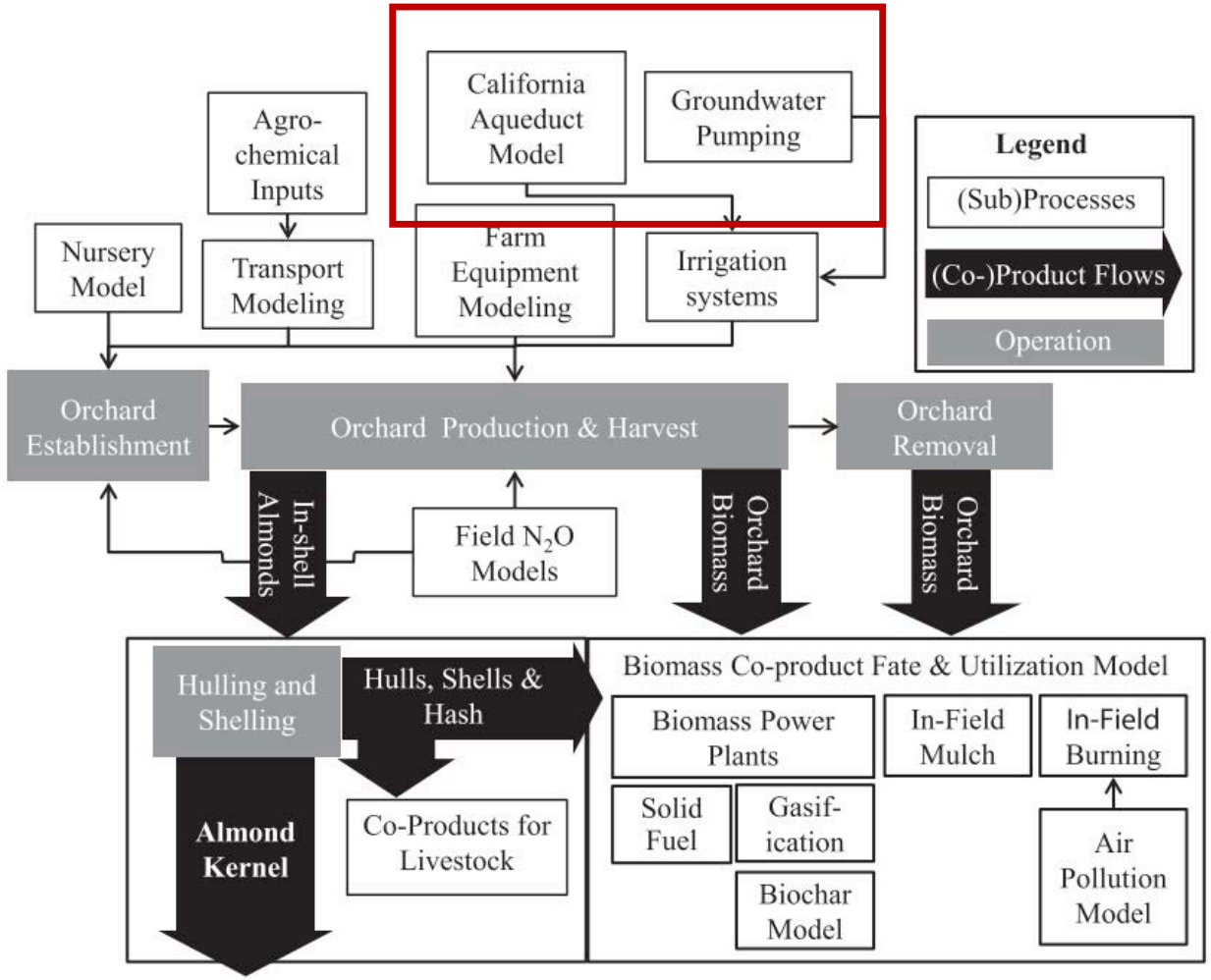


Project: FEW LCA

- Advancing existing research on life-cycle assessment (LCA) of California almond production
  - Refining energy for irrigation water, which varies by:
    - Crop type
    - Surface v. groundwater
    - Location



Model Framework for Life Cycle–based Assessment of Energy Use and Greenhouse Gas Emissions in Almond Production

(Kendall et al. 2015)

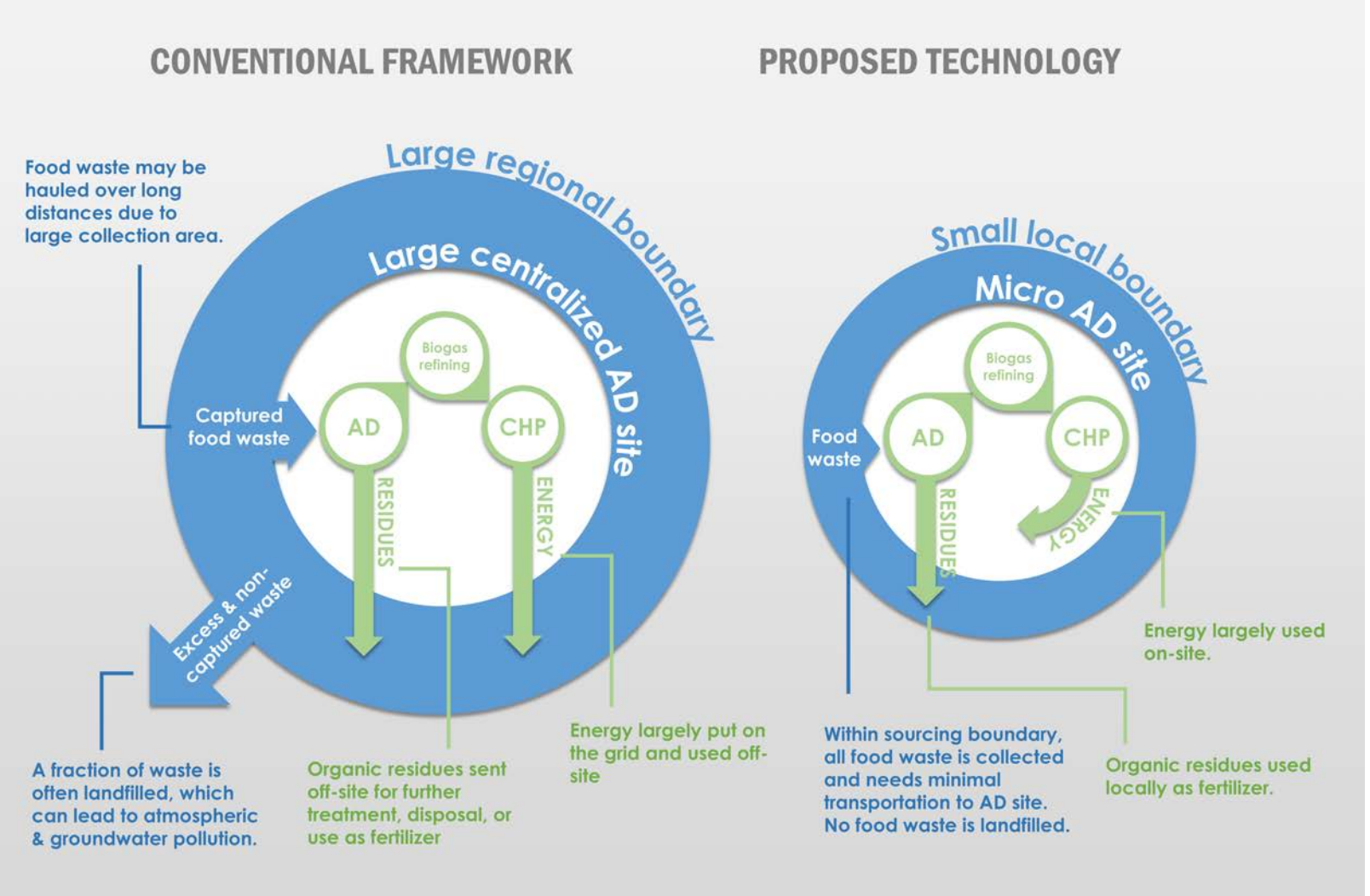
* Adapted from US EPA LCA guidelines

Project: Measuring Crop Loss

- Goal: Improve understanding of on-farm losses for key CA crops
- Partners:
  - World Wildlife Fund
  - Global Cold Chain Alliance
- UC Davis
  - CA crops: tomatoes, leafy greens, and peaches
  - Surveys, interviews and in-field measurement
  - Analysis of water, energy, and other key inputs

Project: Anaerobic Digestion

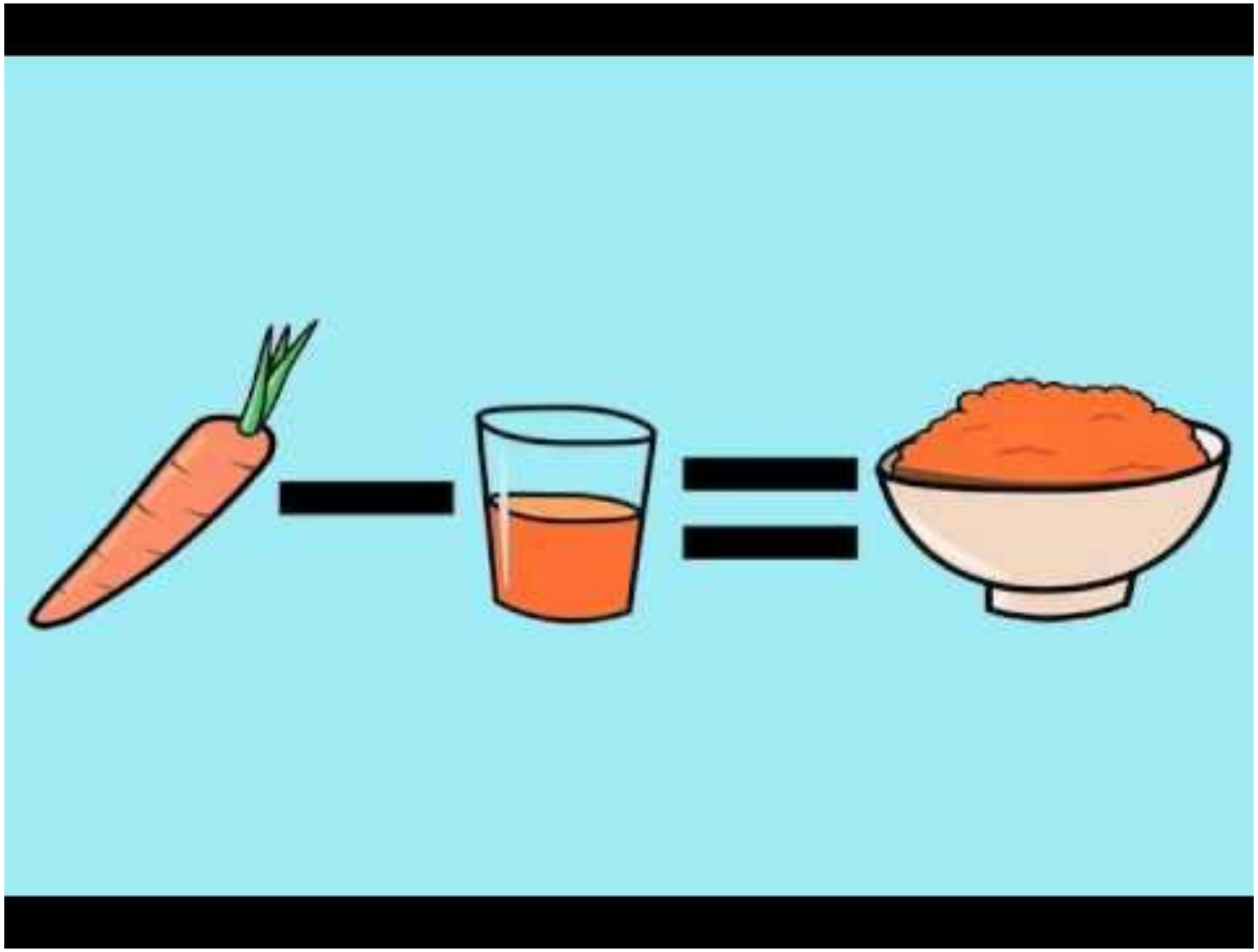
- Using microorganisms to convert organic material → biogas → electricity, heat, and fertilizer
- California legislation, AB 1826 (2014), for mandatory organics recycling
- What to do with all the waste?
- CEC project to research the tradeoff between large centralized facilities vs. smaller decentralized facilities



End of Waste Project

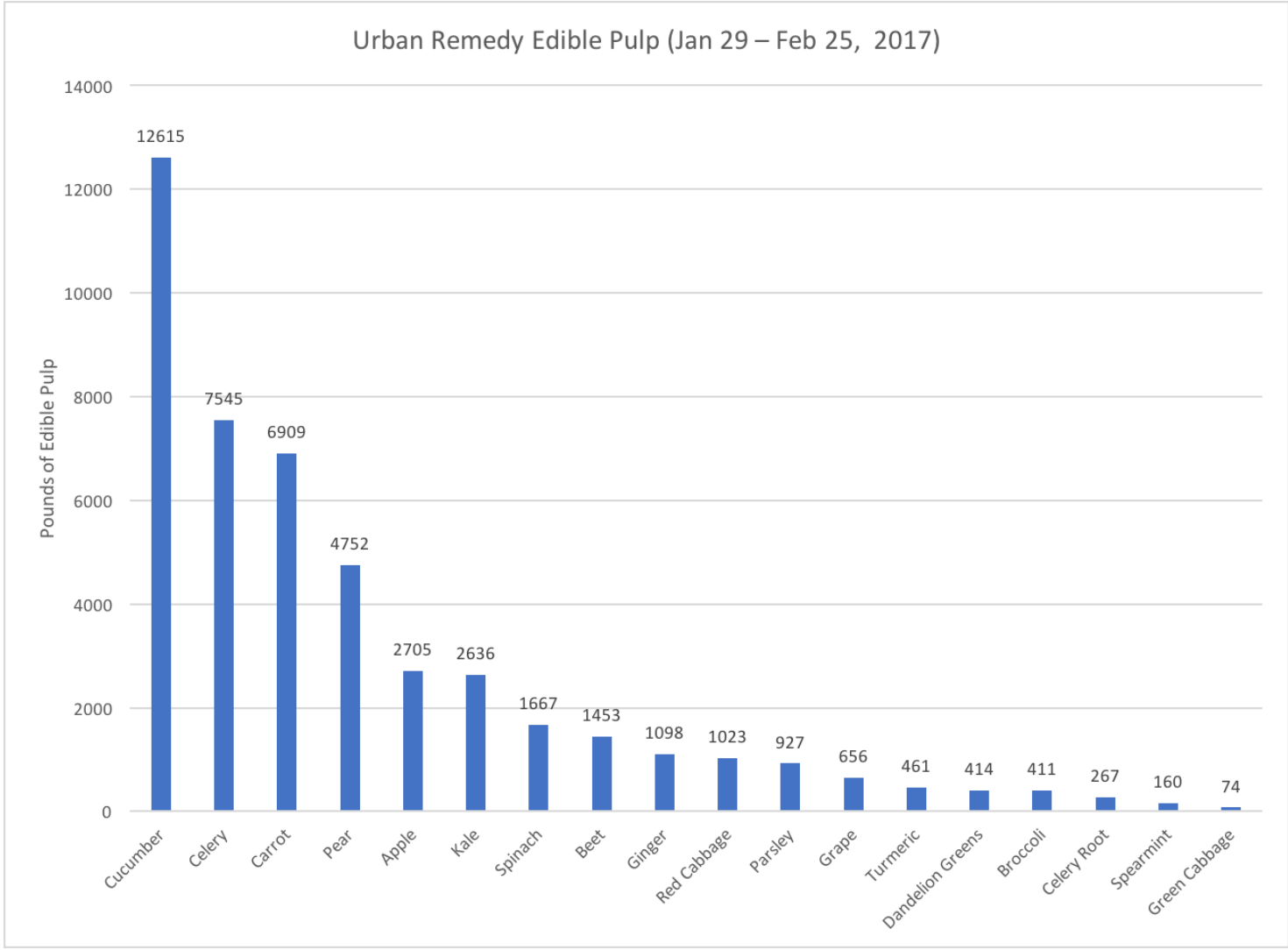
- Participatory project between students, faculty, and industry.
- Formulate three food products using “waste” fruit/vegetable pulp from juice company.
- Jointly achieve sensory, cost, and sustainability objectives.

End of Waste Project



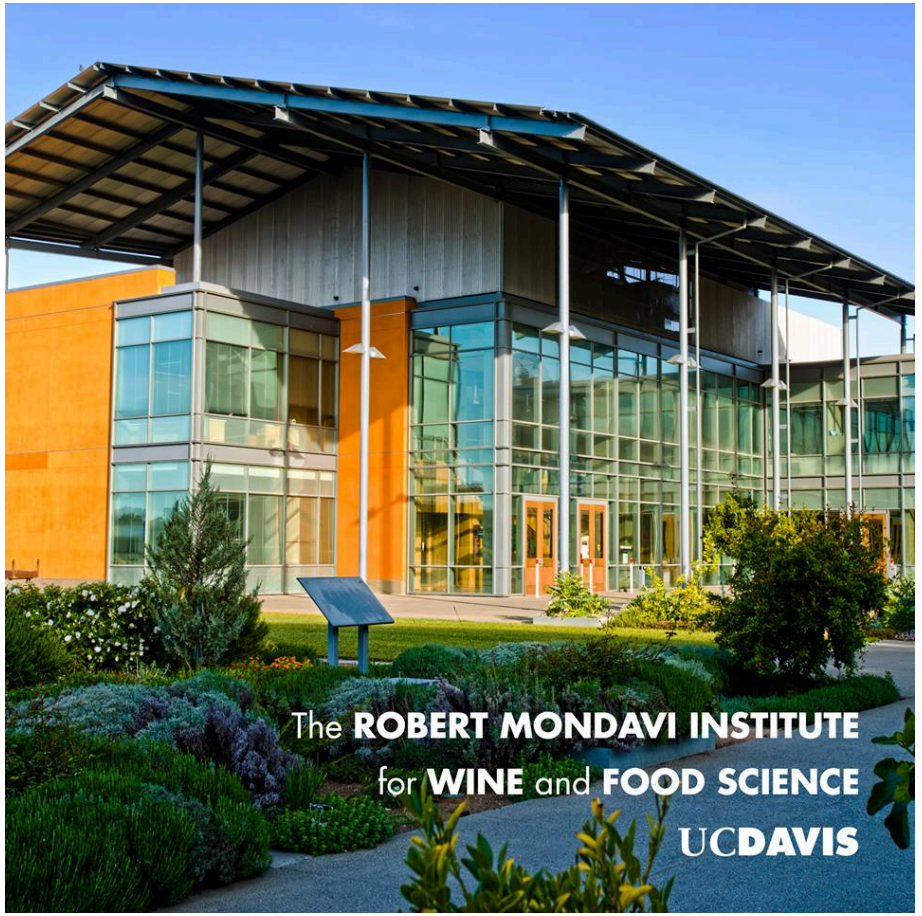
Market Research and Logistics

- Mapping flows of pulp production by product type
- Estimate max growth of production based on available supply
- Understand environmental implications of waste recycling



UC Davis FLW Collaborative

- Organize existing and emerging FLW Research by thematic area:
  - Measurement and characterization
  - Supply chain efficiency
  - Consumer and behavioral science
  - Novel products and markets
  - Advanced recycling solutions
- More than 20 faculty and students from more than 10 departments!
- Kick-off meeting next week
  - 9:30am – 11:30, May 12
  - Location TBD



Information

The application process is now open for FST 298 Design Thinking for Food (Fall 2017), an interdisciplinary graduate seminar in which students learn and apply the tools of the Social Sciences and Design Thinking to address complex food systems challenges. The focus for next fall will be reducing food waste and applications are welcomed from Graduate Students in ANY graduate group, as well as ambitious Juniors and Seniors from ANY Major.

To learn more about the class and/or apply to participate next year please visit:
http://designthinkingforfood.weebly.com/

Instructors:
Charlotte Biltekoff
Lauren Shimek

Thank You

Ned Spang
esspang@ucdavis.edu