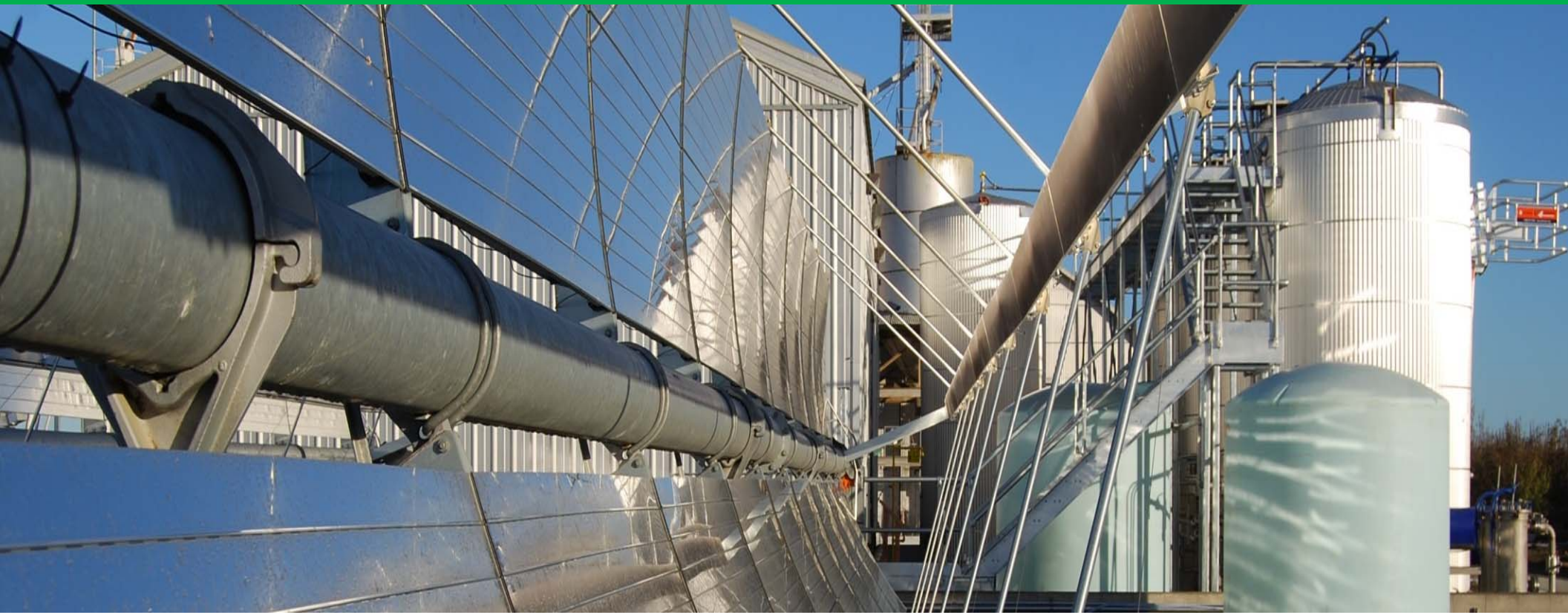
Water Energy Nexus

Idaho National Laboratory, July 27, 2016

Sustainability is at the heart of everything we do



Safe Harbor

The following information contains or may be deemed to contain “forward-looking statements.” By their nature, forward-looking statements involve risks and uncertainties because they relate to events and depend upon circumstances that may or may not occur in the future. Future results of the company may possibly vary from the results expressed or implied herein by forward-looking statements. The company undertakes no obligation to update or revise any forward-looking statements.

What We Do

Improve the environment and local communities

Reduce greenhouse gases

Create “green collar” jobs in disadvantaged communities

Improve energy security

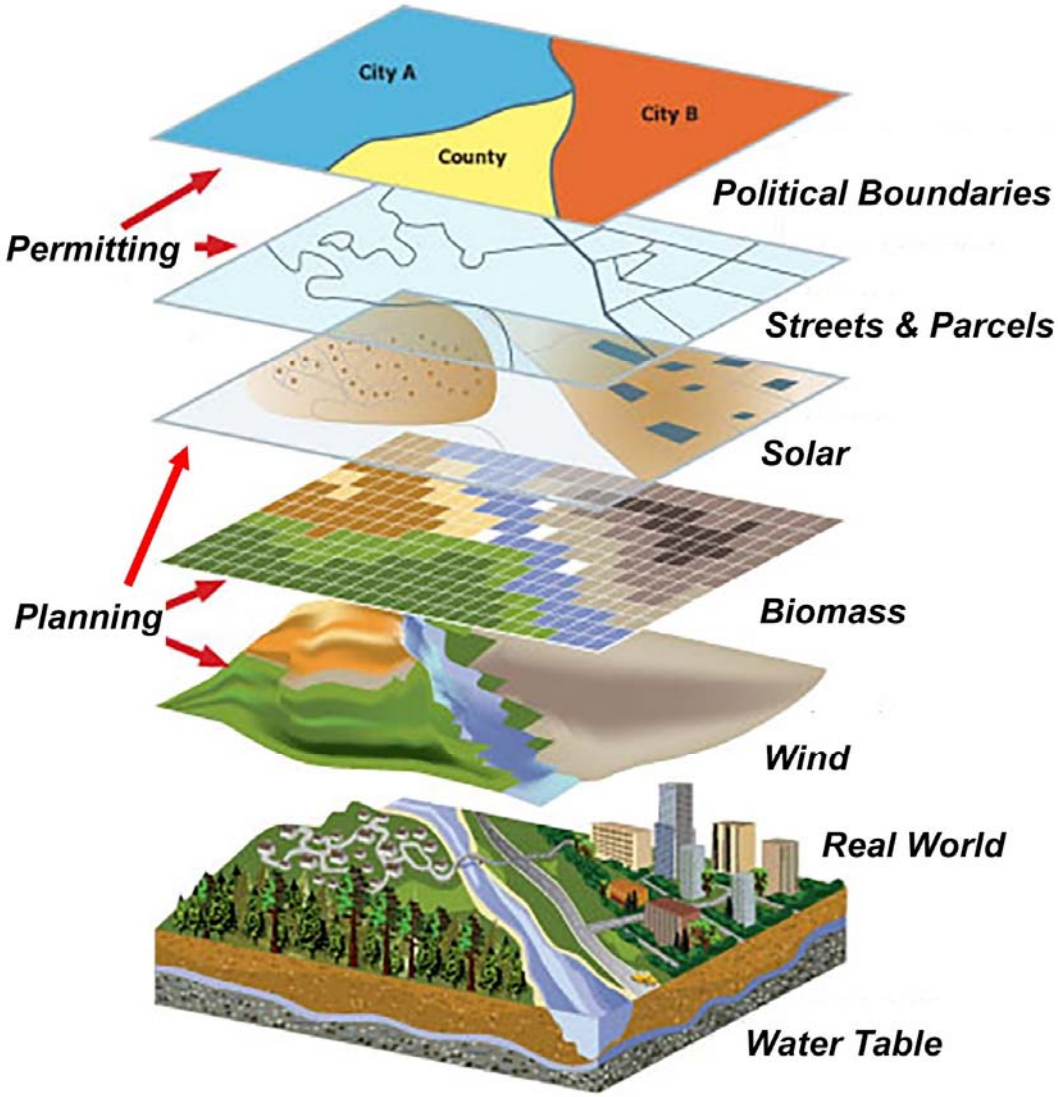
How We Do It

Deploy economically viable Distributed Integrated Renewable Clean Energy Technology (DIRECT) systems that produce biofuels and renewable energy

Water & Energy at Biodico

- Zero Net Energy Farm (ZNEF) awarded a grant from the CA Energy Commission
- Resource Assessment
- Technology Trade Study
- Permitting
- Financial Vehicles
- Create user friendly interface for guiding agricultural interests through the development process
- Shovel-ready in 20 months

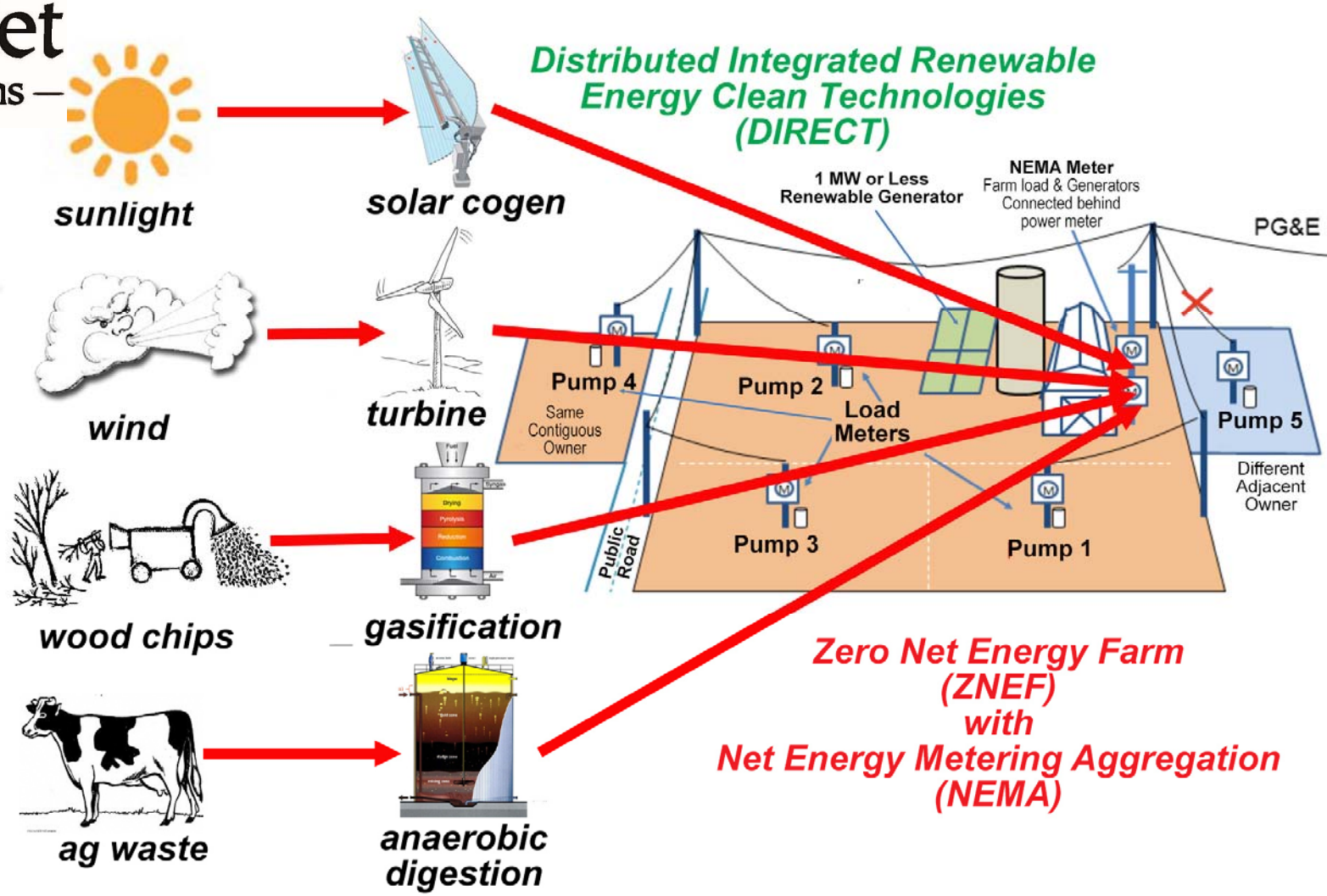
Zero Net
— Energy Farms —



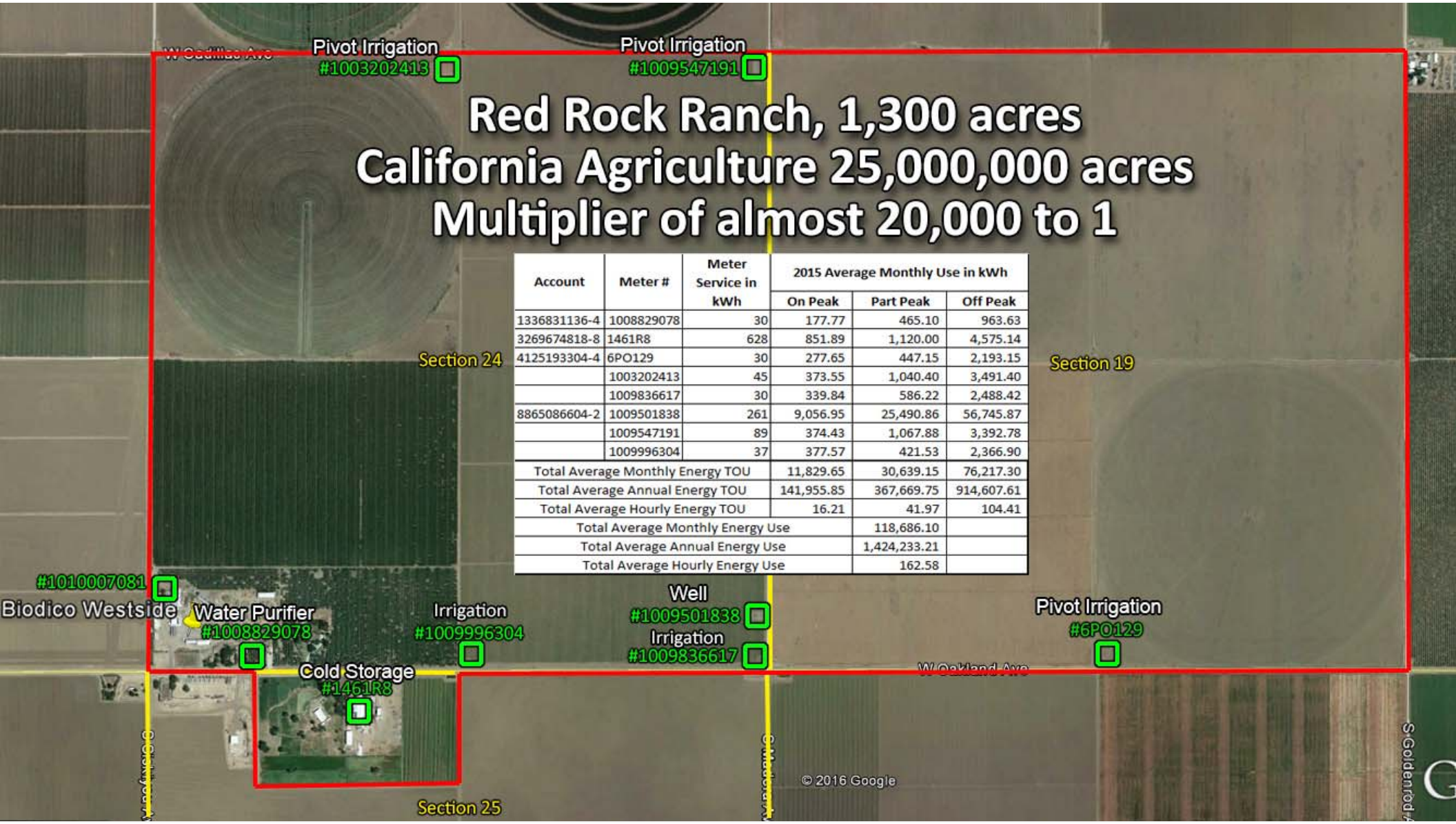
Zero Net
— Energy Farms —

ZNEF & NEMA

Enabling Agricultural Operations To Generate All of Their Own Electricity and Heat from On-site Renewable Resources, While Reducing Greenhouse Gases



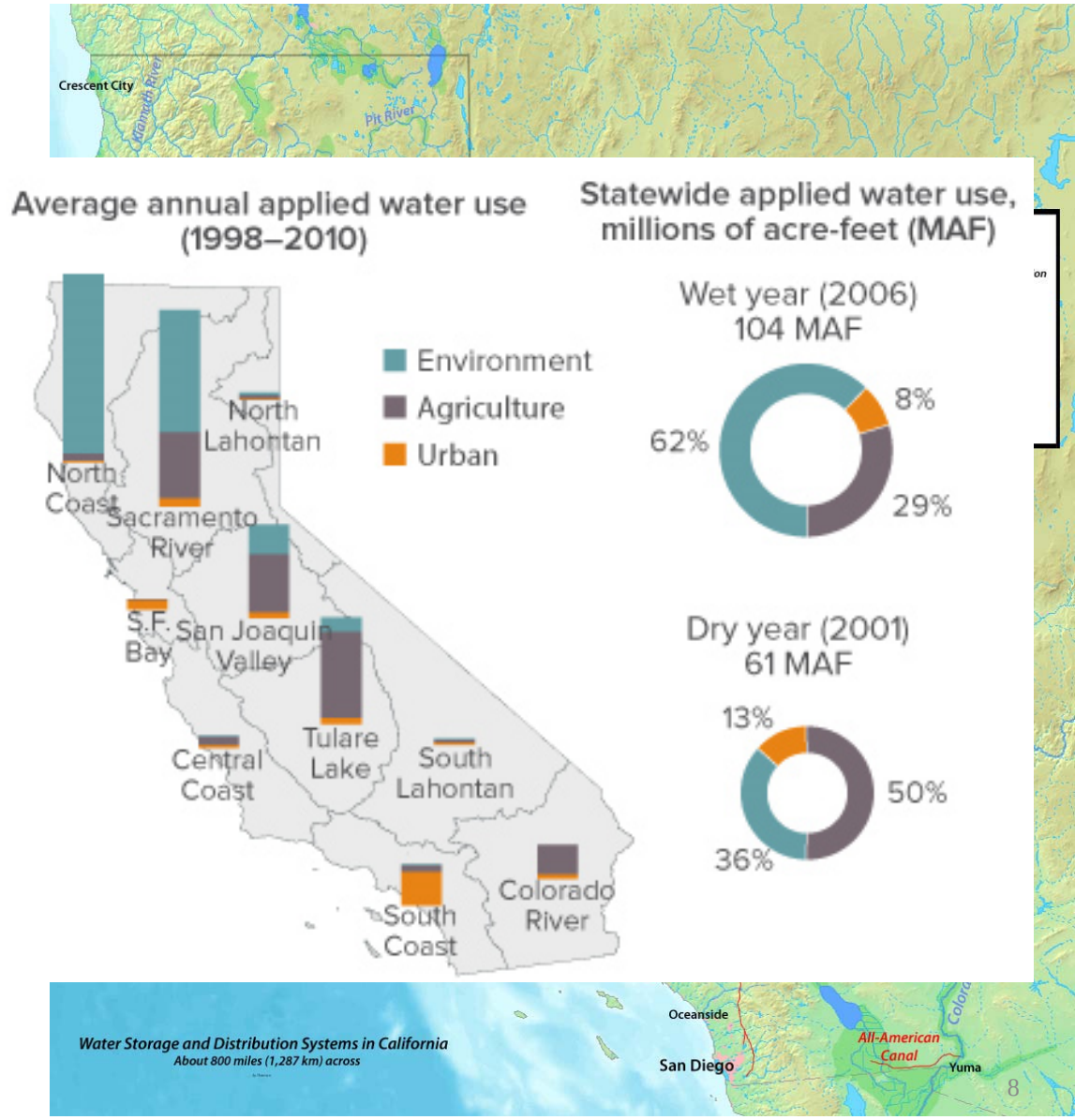
Red Rock Ranch, 1,300 acres
California Agriculture 25,000,000 acres
Multiplier of almost 20,000 to 1



Account	Meter #	Meter Service in kWh	2015 Average Monthly Use in kWh		
			On Peak	Part Peak	Off Peak
1336831136-4	1008829078	30	177.77	465.10	963.63
3269674818-8	1461R8	628	851.89	1,120.00	4,575.14
4125193304-4	6PO129	30	277.65	447.15	2,193.15
	1003202413	45	373.55	1,040.40	3,491.40
	1009836617	30	339.84	586.22	2,488.42
8865086604-2	1009501838	261	9,056.95	25,490.86	56,745.87
	1009547191	89	374.43	1,067.88	3,392.78
	1009996304	37	377.57	421.53	2,366.90
Total Average Monthly Energy TOU			11,829.65	30,639.15	76,217.30
Total Average Annual Energy TOU			141,955.85	367,669.75	914,607.61
Total Average Hourly Energy TOU			16.21	41.97	104.41
Total Average Monthly Energy Use				118,686.10	
Total Average Annual Energy Use				1,424,233.21	
Total Average Hourly Energy Use				162.58	

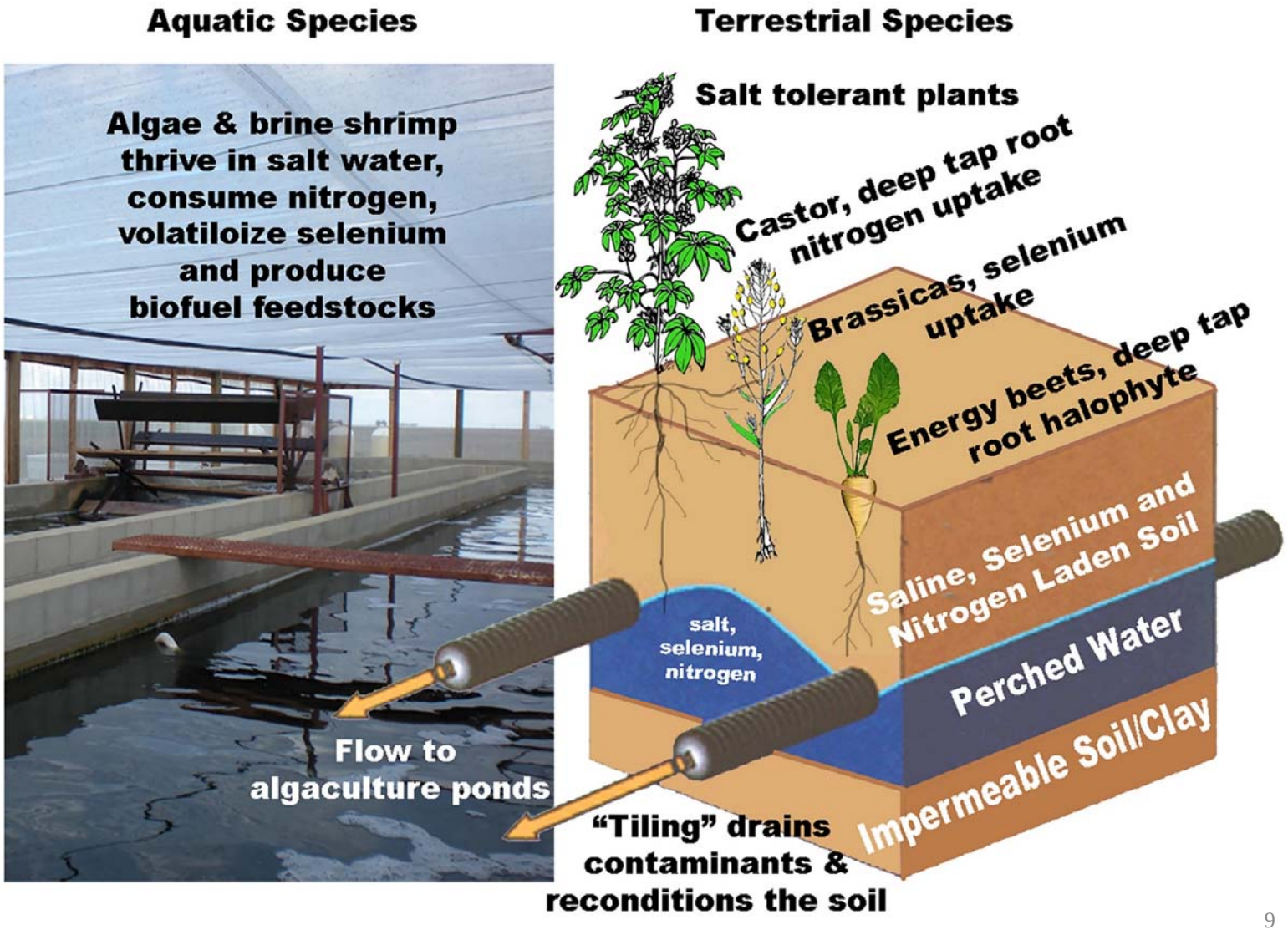
CA Ag Water Energy Nexus

- California's interconnected water system serves over 30 million people and irrigates over 5,680,000 acres of farmland.
- As the world's largest, most productive, and most controversial water system, it manages over 40,000,000 acre-feet of water per year.
- Statewide, average water use is roughly 50% environmental, 40% agricultural, and 10% urban.
- "Water-related energy use in California also consumes approximately 20 percent of the state's electricity." CA Energy Commission
- The 100 thermal power plants examined use nearly 123,000 acre-feet of water per year. Among these are 30 power plants that use surface water, 20 that use groundwater, and 50 that rely on recycled and degraded groundwater as the primary water source. This does not include geothermal powerplants which use significant amounts of water.



Tiling

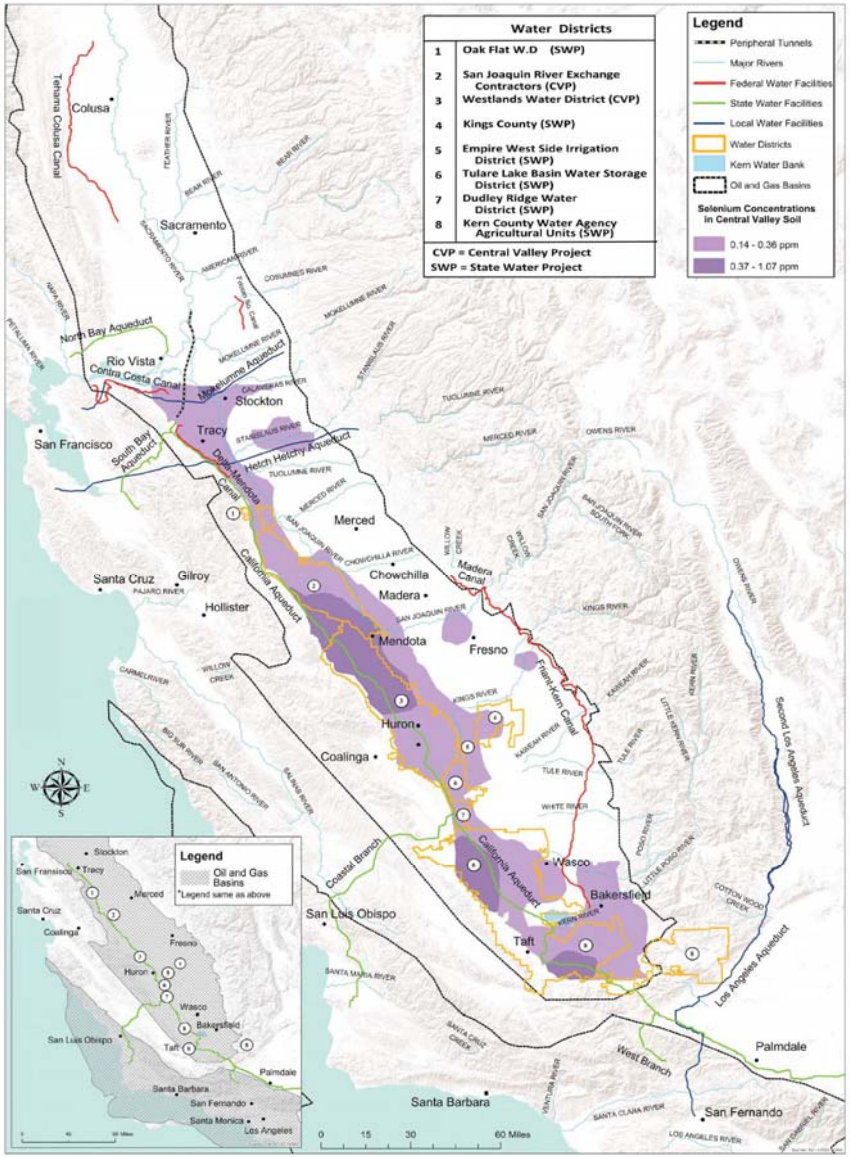
- The water cycle does not end with irrigation.
- Arid areas need to flush the soil to prevent salt buildup.
- High salt, mineral and fertilizer end up in drainage ditches.
- Instead of contaminating waterways, tiled water can be used in algaculture to produce biofuel, renewable energy and valuable co-products.



Bioremediation

- Westlands Water District is the largest agricultural water district in the United States, made up of more than 1,000 square miles of prime farmland in western Fresno and Kings Counties
- Selenium accumulates as the result of irrigation
- 80,000 acres of selenium contaminated land has been set aside with no water rights – dry land farming only
- Brassicas and algaculture can be farmed on set-aside land, both bioremediate selenium

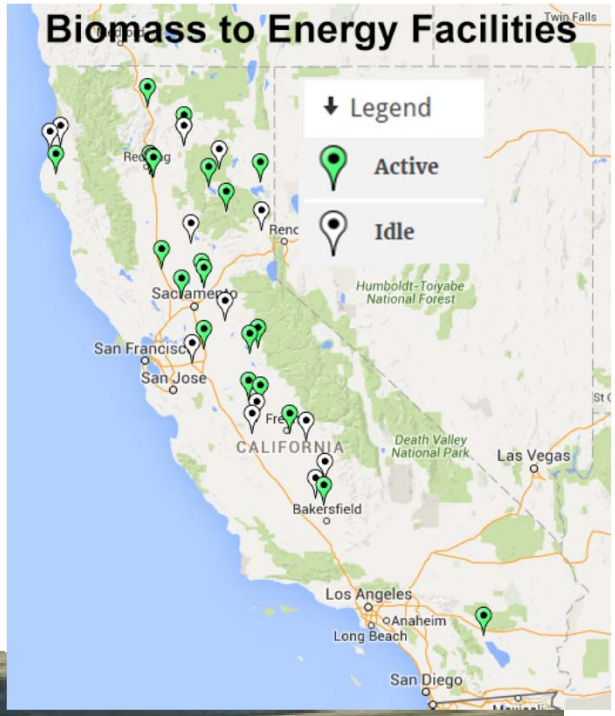
Dr. Gary Banuelos, USDA ARS resident expert on selenium bioremediation



Orchards & Vineyards

- 2,500,000 acres of orchards, 865,000 acres of vineyards, intercropping potential on 600,000 acres, generates over 83 mgy biodiesel
- Cover crop preserves water & harvests deep nitrogen
- Biomass energy plant closings = open burning
- Farm-scale gasifiers can use wood chips to create renewable CHP

Annual CA Orchard Acreage			
Crop	Bearing	Young	Oil Potential
	17 years	3 years	66%/acre
	acres	acres	gallons
Almonds	750,000	112,500	22,074,324
Apples	18,000	3,176	623,275
Apricots	10,800	1,906	373,965
Avocados	61,000	10,765	2,112,210
Cherries	29,000	5,118	1,004,165
Dates	7,670	1,354	265,584
Grapes	878,000	154,941	30,401,971
Grapefruit	9,400	1,659	325,488
Lemons	45,000	7,941	1,558,188
Oranges	213,000	37,588	7,375,421
Peaches	50,000	8,824	1,731,320
Pears	14,000	2,471	484,769
Pistachio	137,000	24,176	4,743,816
Plums	61,000	10,765	2,112,210
Walnuts	227,000	40,059	7,860,191
TOTAL	2,510,870	423,242	83,046,898



Water Recycling & Recovery

- Australia Biodico Facility – 80% water recycling
- Biodico Westside – algaculture, triple effect evaporator and RO
- Technology is there, but is it economically viable?

Next Gen Feedstocks

Algae

Castor

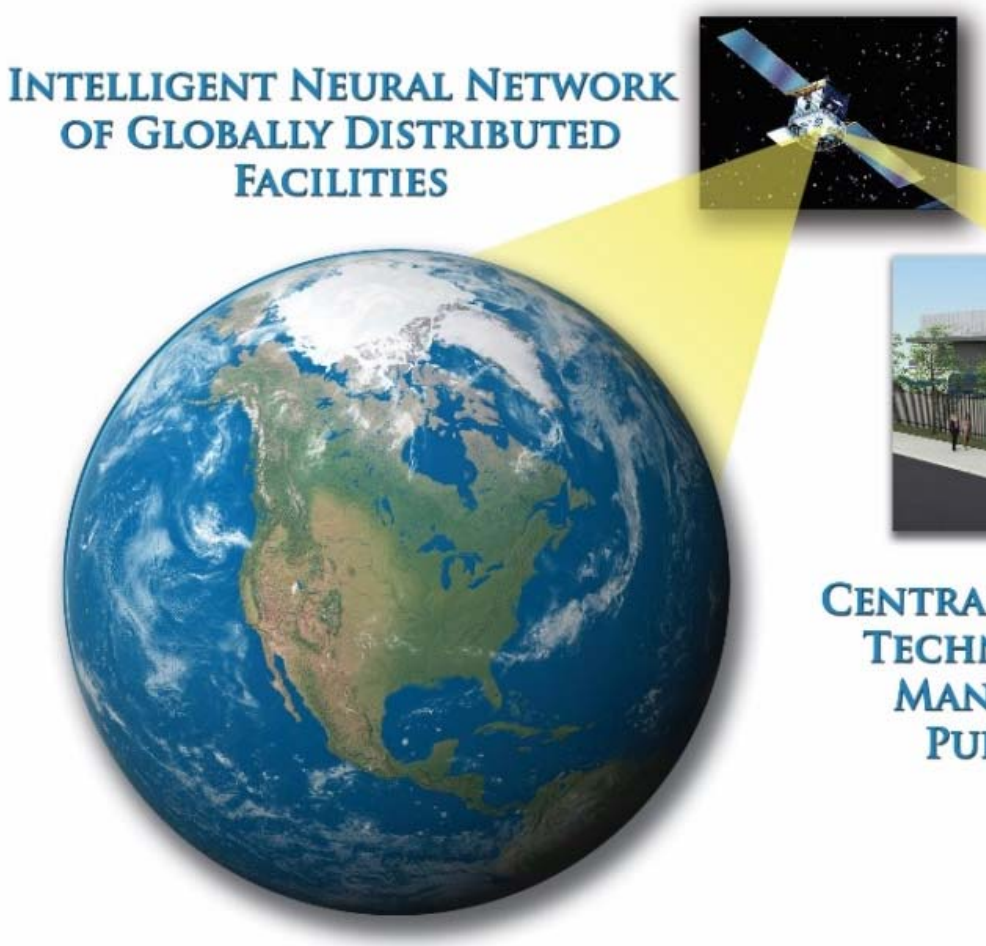
Intercropping Brassicas

Jatropha

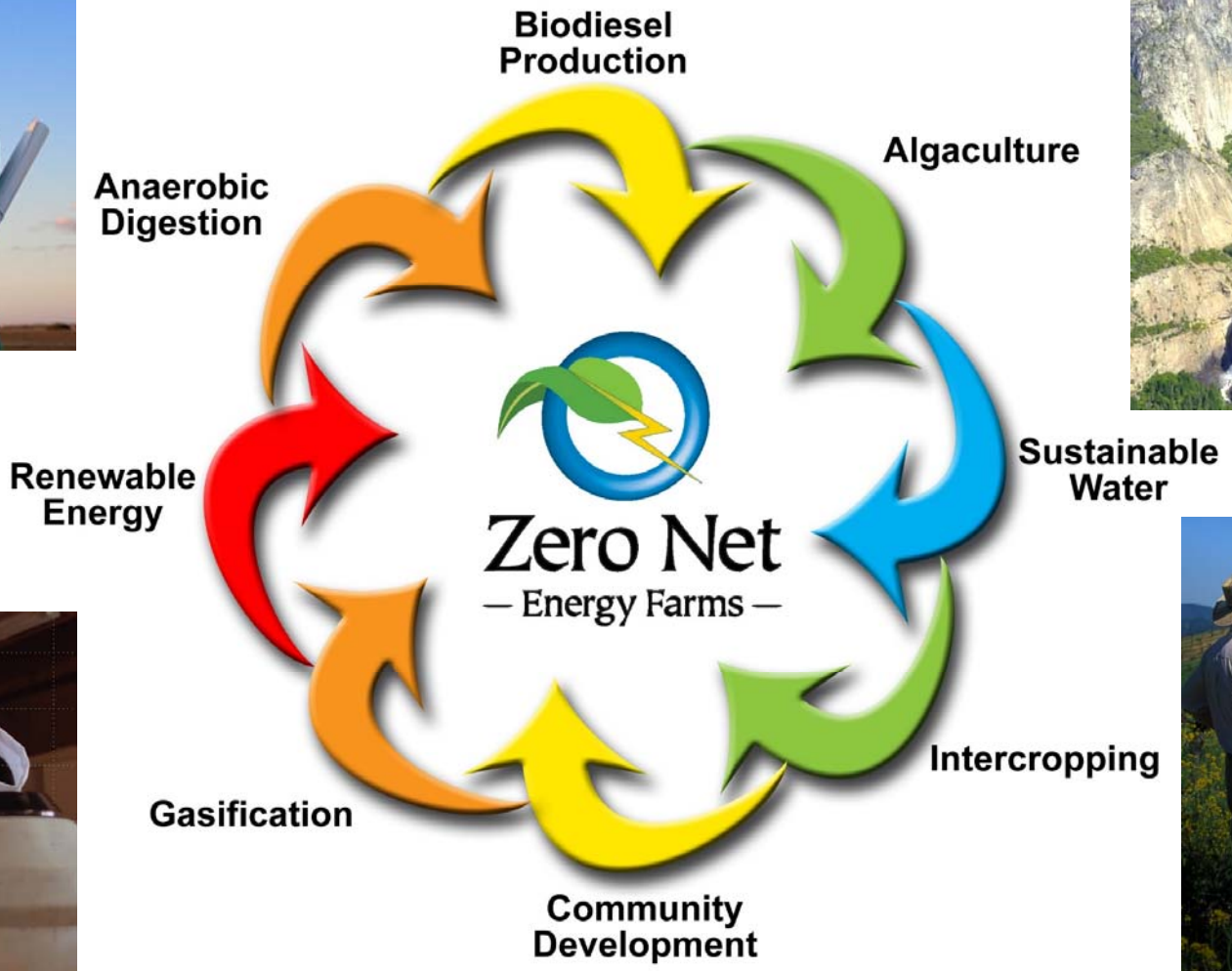
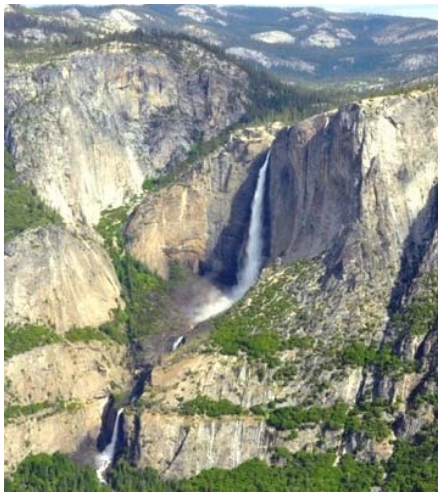
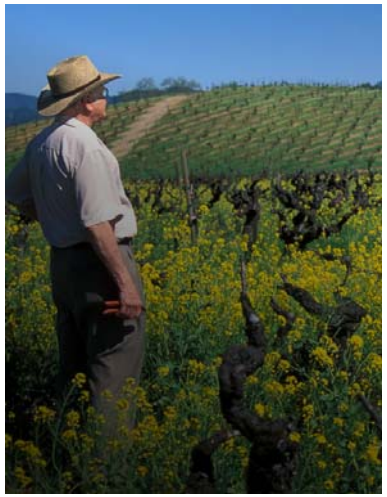
Agricultural Waste

“Glocalization”

- **Biomass facilities operate best on a distributed basis**
- **Diseconomies of scale mitigated by neural network**
- **Experiential learning occurs between nodes**



CENTRALIZED COMMAND & CONTROL
TECHNICAL SUPPORT & TRAINING
MANAGEMENT & ACCOUNTING
PURCHASING & MARKETING


Biodiesel Production
Algaculture
Sustainable Water
Intercropping
Community Development
Gasification
Renewable Energy
Anaerobic Digestion
Zero Net
— Energy Farms —