Water-Energy-Food Nexus: California Food Processing

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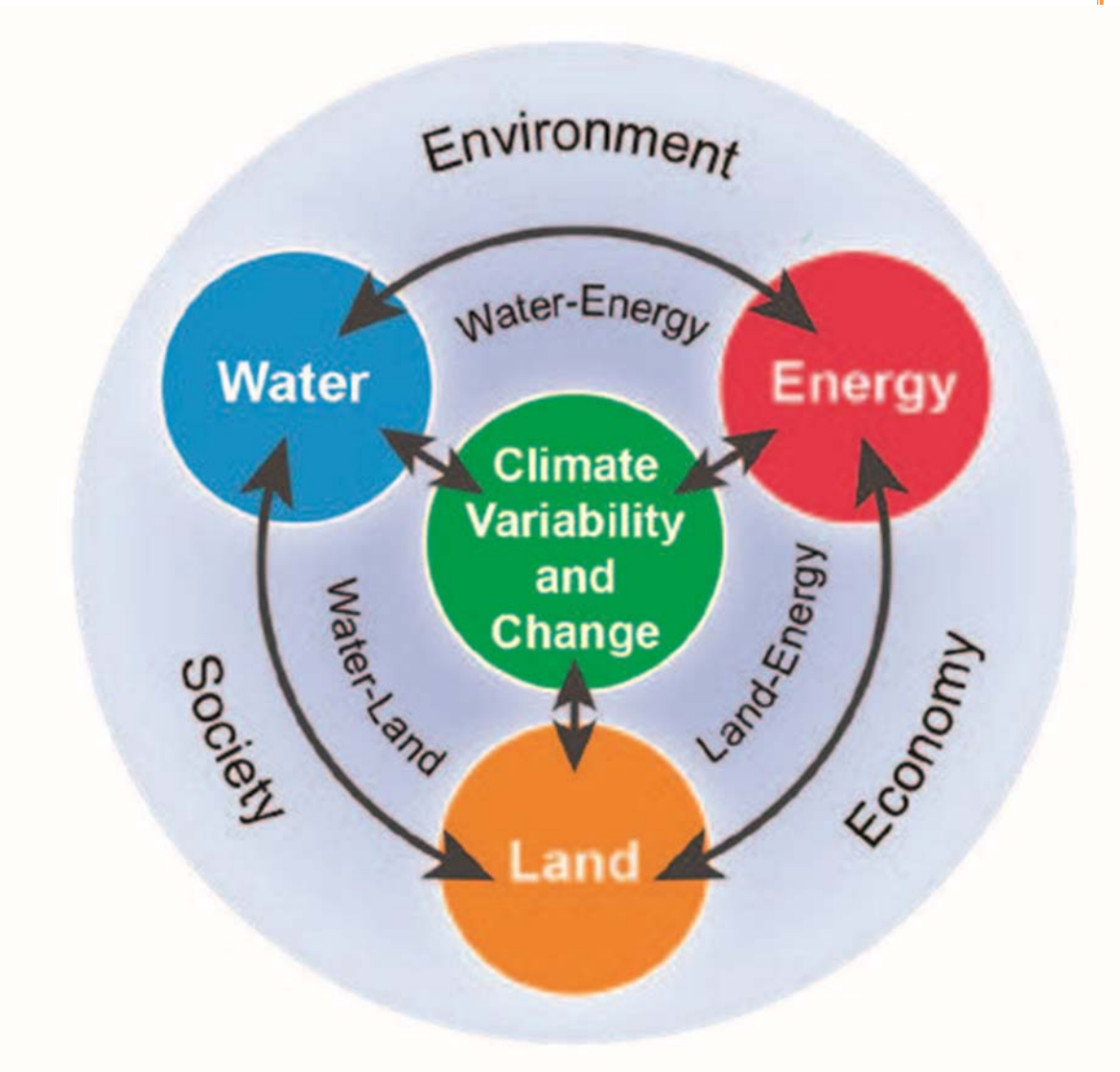
Outline

- Introduction to Water-Energy-Food Nexus
  - WEFN
- Introduction to California
  - The Central Valley
  - Agriculture & food processing
- WEFN challenges facing the food processing industry in California
- WEFN solutions in California
- Summary

The Water-Energy-Food Nexus

- Water security
  - Drinking, irrigation, environmental, etc.
- Energy security
  - Available, reliable
- Food security
  - Agriculture & land-use
- Historically, these needs are managed independently



The Water-Energy-Food Nexus

- Managing water, energy, & food as interrelated resource is necessary in the face of climate change & population growth
- World population projected to reach 9.8 billion in 2050
- Climate change is adding new uncertainty
  - Drought, floods
  - Arid vs. wet

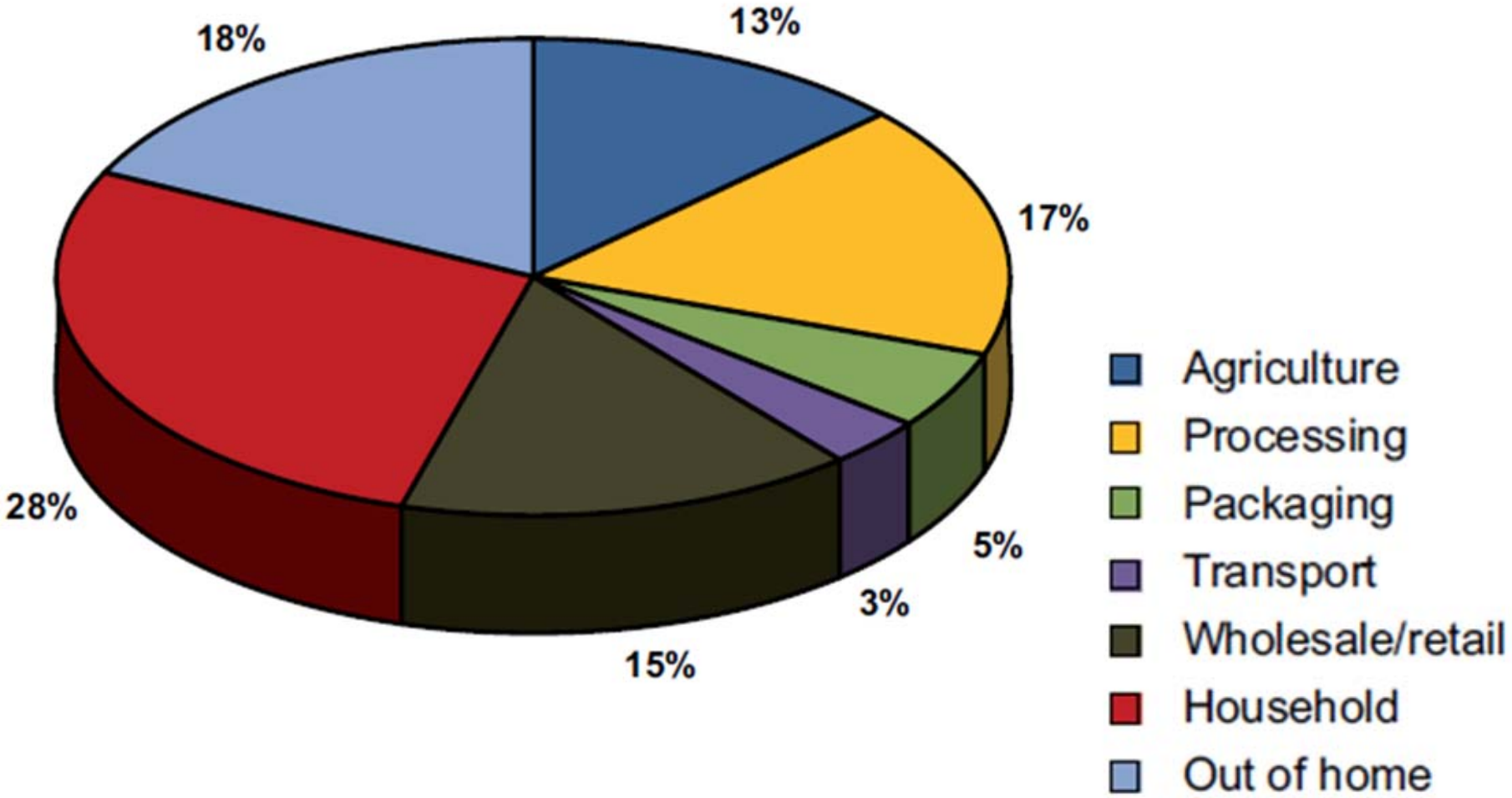
Water-Energy-Food Nexus Defined

- Describes the **complex** and **inter-related** nature of our global resources systems
- The Nexus approach considers the different dimensions of water, energy and food **equally**
- Recognizes the **interdependencies** of resource
- It forces us to think of the **impacts** a decision in one sector can have on other sectors
- **Anticipating potential trade-offs & synergies**, we can then design, appraise and prioritize response options that are viable across different sectors

Food Production & WEFN

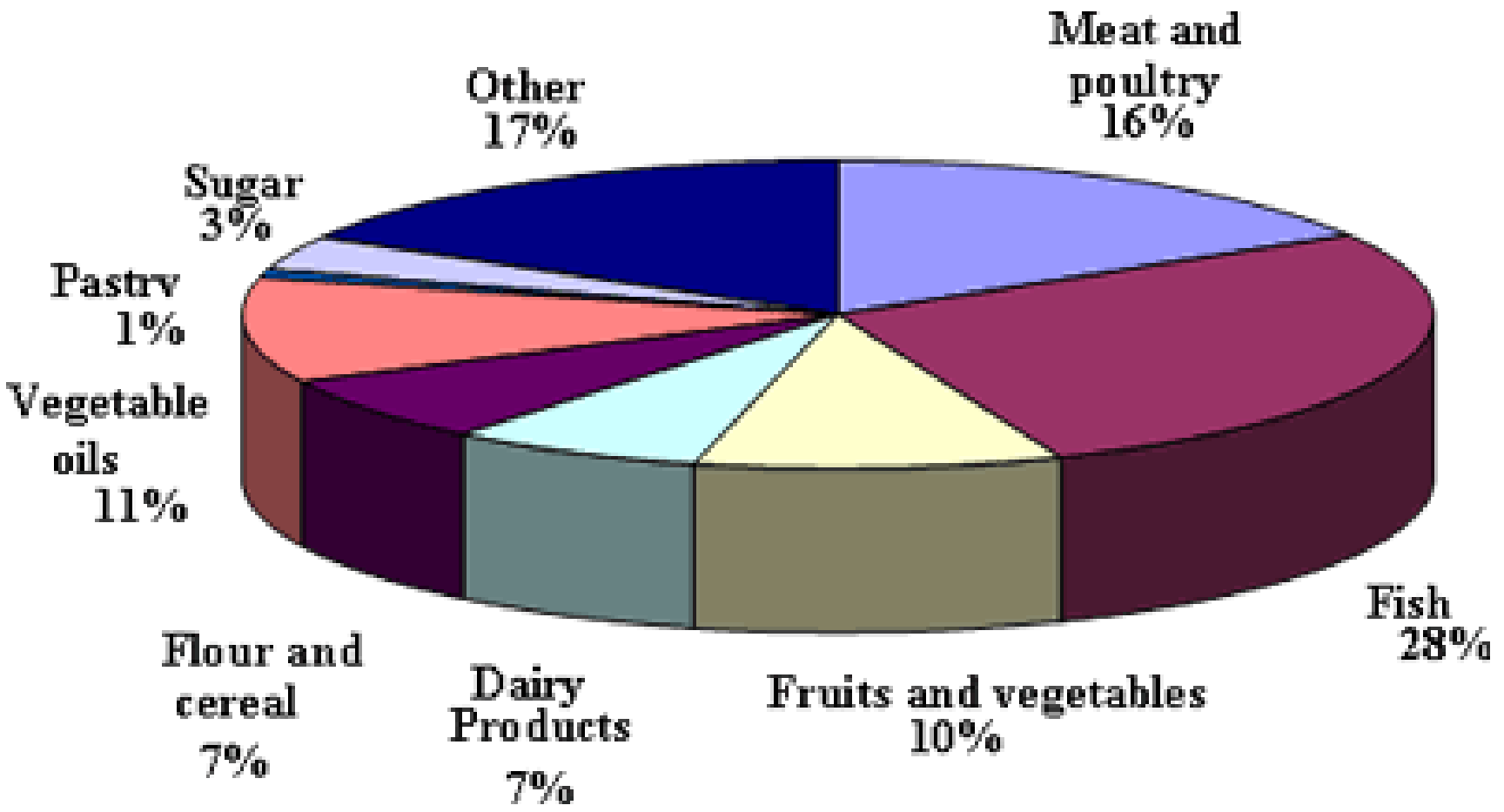
- Food production & associated supply chains consume about **30 percent** of total energy consumed globally
- Energy is required to produce, transport and distribute food
- Energy consumption is expected increase as 60 percent more food will need to be produced in order to feed the world population in 2050

Food Processing Energy Use



Annu. Rev. Environ. Resour. 2011. 36:223–46

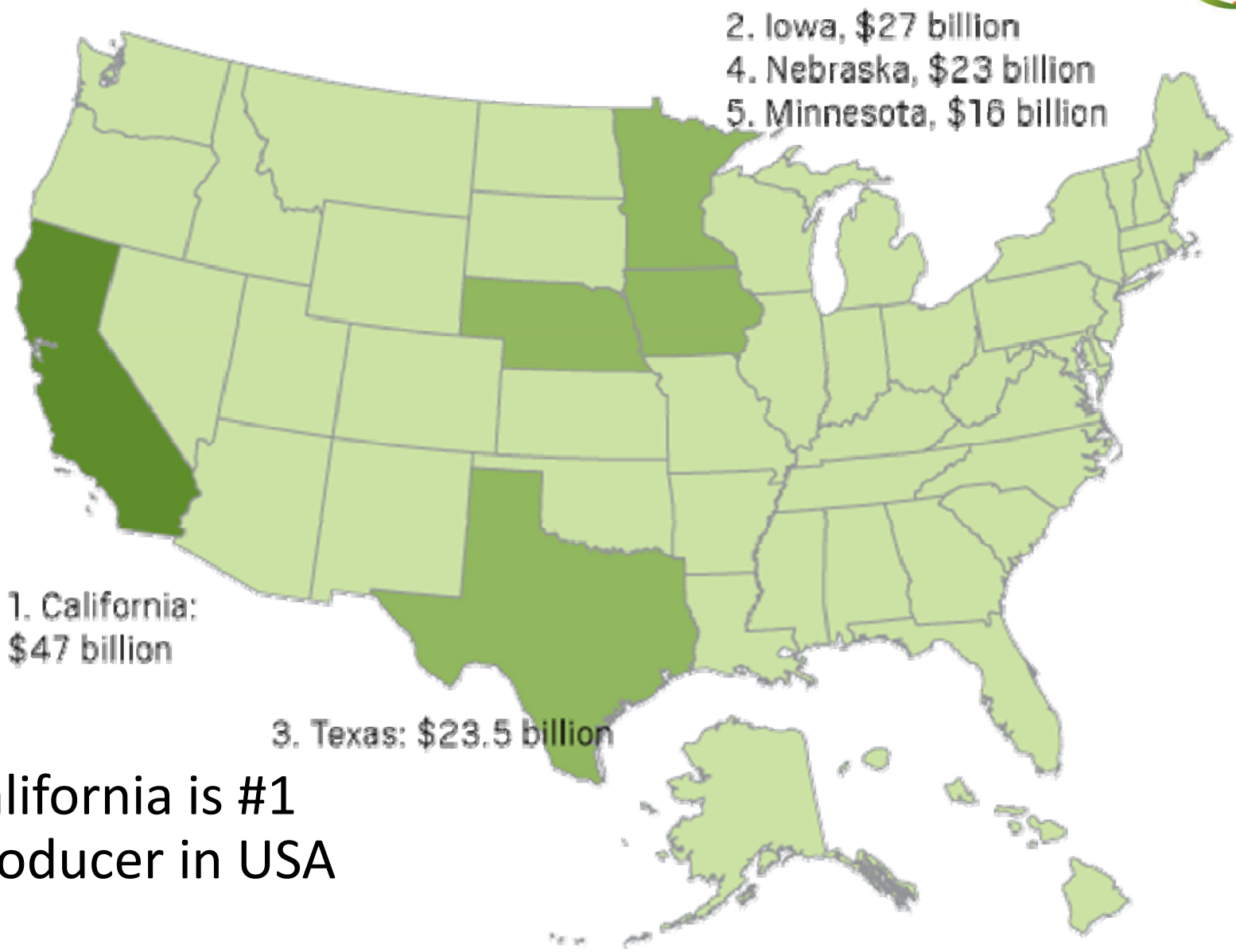
Food Processing Water Use



Environnent Canada, Survey 1991

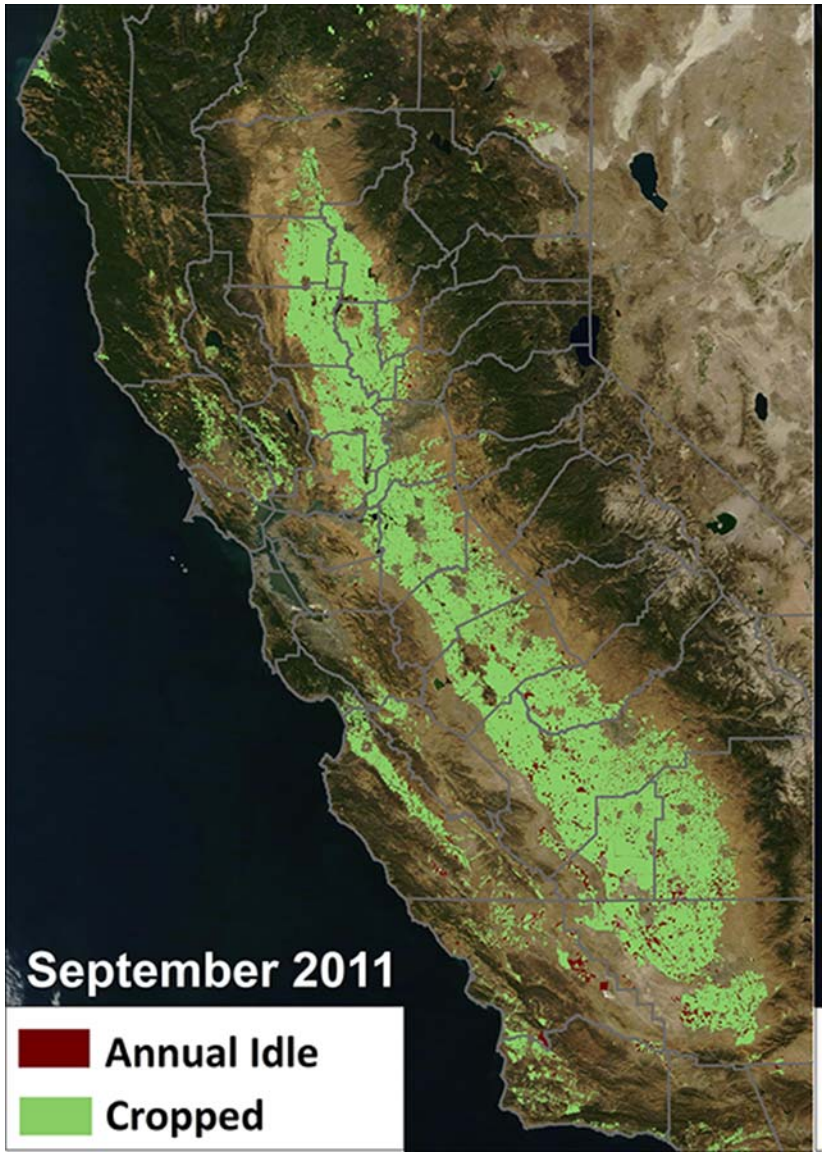
CALIFORNIA &
FOOD PROCESSING

California Food Production

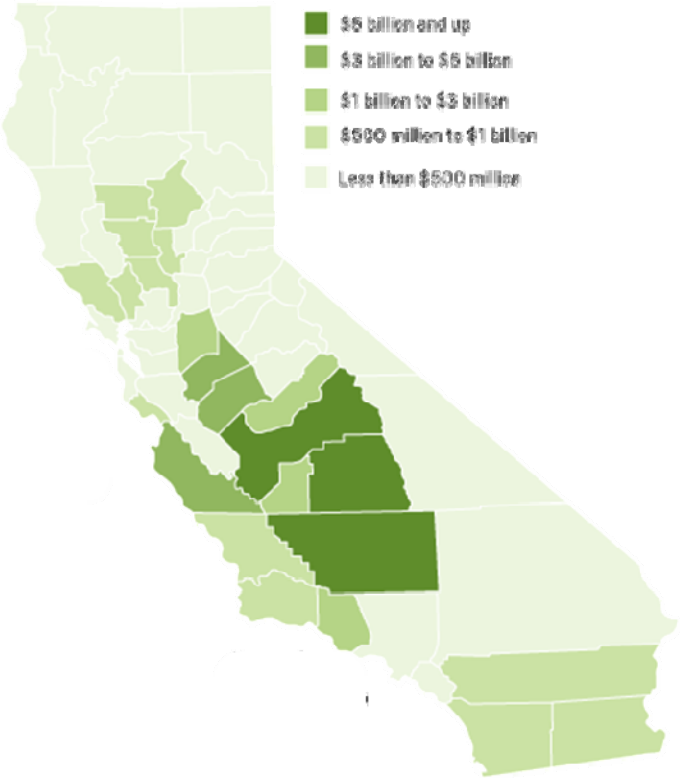


- California is #1 producer in USA

California Food Production



- Central Valley
  - Major Production
- Central Coast



Central Valley 100% US Production

Almonds

Figs

Olives

Peaches

Artichokes

Kiwifruit

Dates

Pomegranates

Raisins

Sweet rice

Pistachios

Plums

Walnuts

Food Processing (California)

- Food processing is a $50 billion dollar industry
- Third largest industrial energy user in the state
- California's great Central Valley is home to over 3000 factory sites
- Has the world's largest single factory sites for
  - Processing fluid milk (California Dairies Inc.)
  - Cheese (Hilmar Cheese Company)
  - Milk powder/butter (California Dairies, Inc.),
  - Wine (E & J Gallo),
  - Poultry (Foster Farms)

Food Processing W&E Use (California)

Food Processing Sector	Water (Million Gallons)	Gas (Million Therms)	Electricity (Million KWH)
Fruits & Vegetables[1]	30,000	300-400	600-800
Dairy			
Cheese[2]	600	43	583
Milk Powder/Butter[3]	360	33	130
Meat			
Beef[4]	1200	5	88
Poultry[5]	2000	40	360
Wine[6]	2900	23	406
Rice[7]	Negligible	41	316
Refrigerated Warehouses[8]	Negligible	Negligible	1000

Food Processing Challenges in CA

- The energy crisis in the 1990's
  - Labor policy
- Resulted in factory closures
- Industry consolidation across the state
- Established Food Industry Advisory Committee
  - Provide technical support to the industry
  - Works with universities, government
- Incorporate modern automated & energy efficient technologies
- Technology to track and trace food at all points in the process

Food Processing Challenges

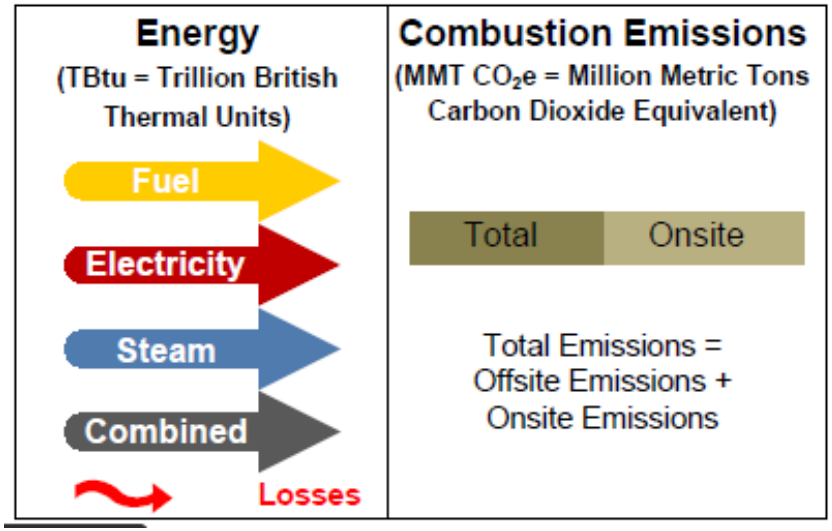
- Current challenges are WEFN issues
- Rising electrical & power prices
- Increased competition for water supply
- Increased problems with waste management
  - Wastewater disposal practices must change
  - Salt balance program in Central Valley
- California drought changed the rules
  - 7 year drought
  - Focused attention on water crisis

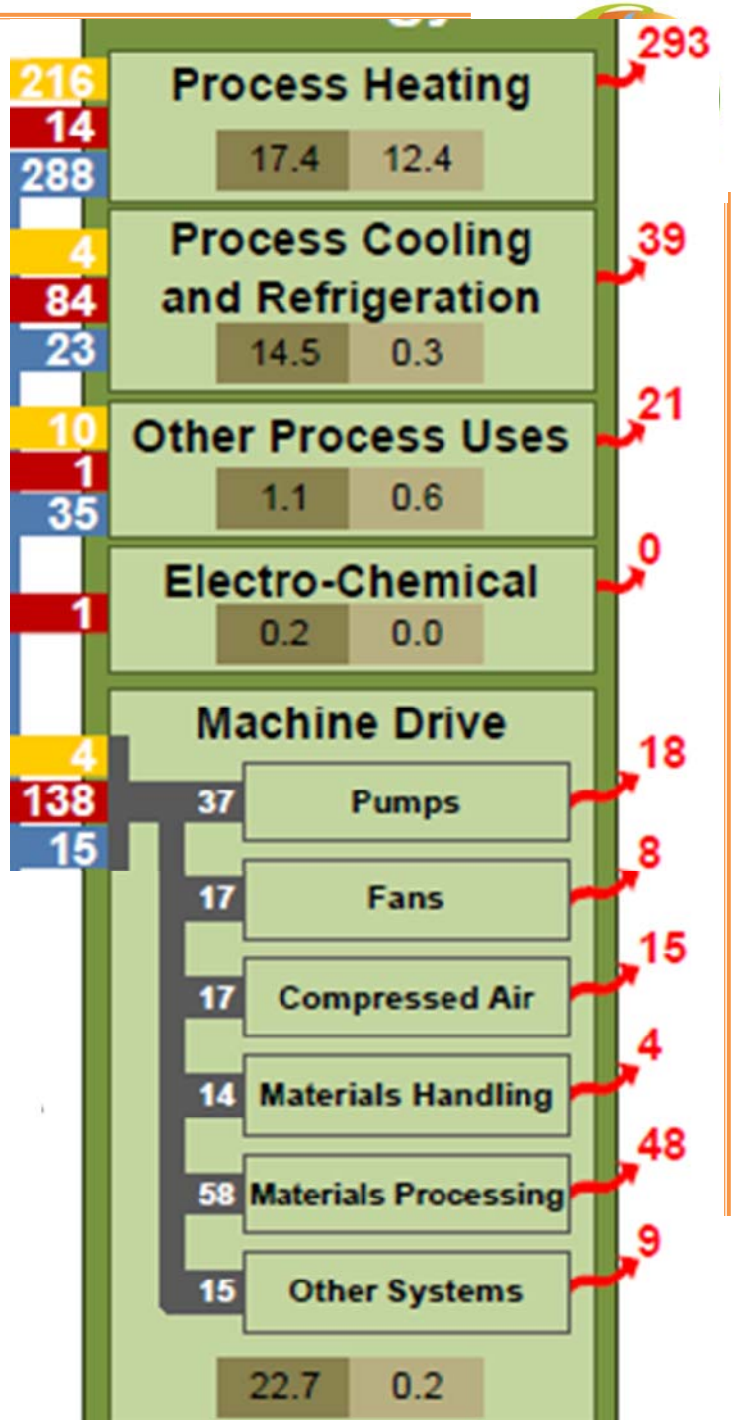
Food Industry Advisory Committee

- Overall systems approach
- Incorporate multiple variables & efficiencies
  - Power, water, raw materials, product, waste, externalities, etc.
- Total integrate & process control operation
- Updating or incorporating new equipment
  - Pumps, motors, sensors, & separations
- Track & trace all raw materials & process additives
- Partner to utilize all components & wastes

Measure & Monitor

- Understand system inefficiencies
- Implement best practices
  - Department of Energy





Food Processing Energy Analysis

Food Processing Sector	Pumps Motors Fans Conveyors Lighting	Pasteurization Heating Systems Evaporators Dryers Sterilization	Cooling Freezing Refrigeration	Sanitation Clean in Place
Fruits & Vegetables	10	70	15	5
Dairy				
Cheese	35	40	20	5
Milk Powder	25	55	15	5
Meat				
Beef	30	20	40	10
Poultry	30	20	40	10
Wine	50		40	10
Rice (drying)	20	80		
Refrigerated Warehouses	15		80	5

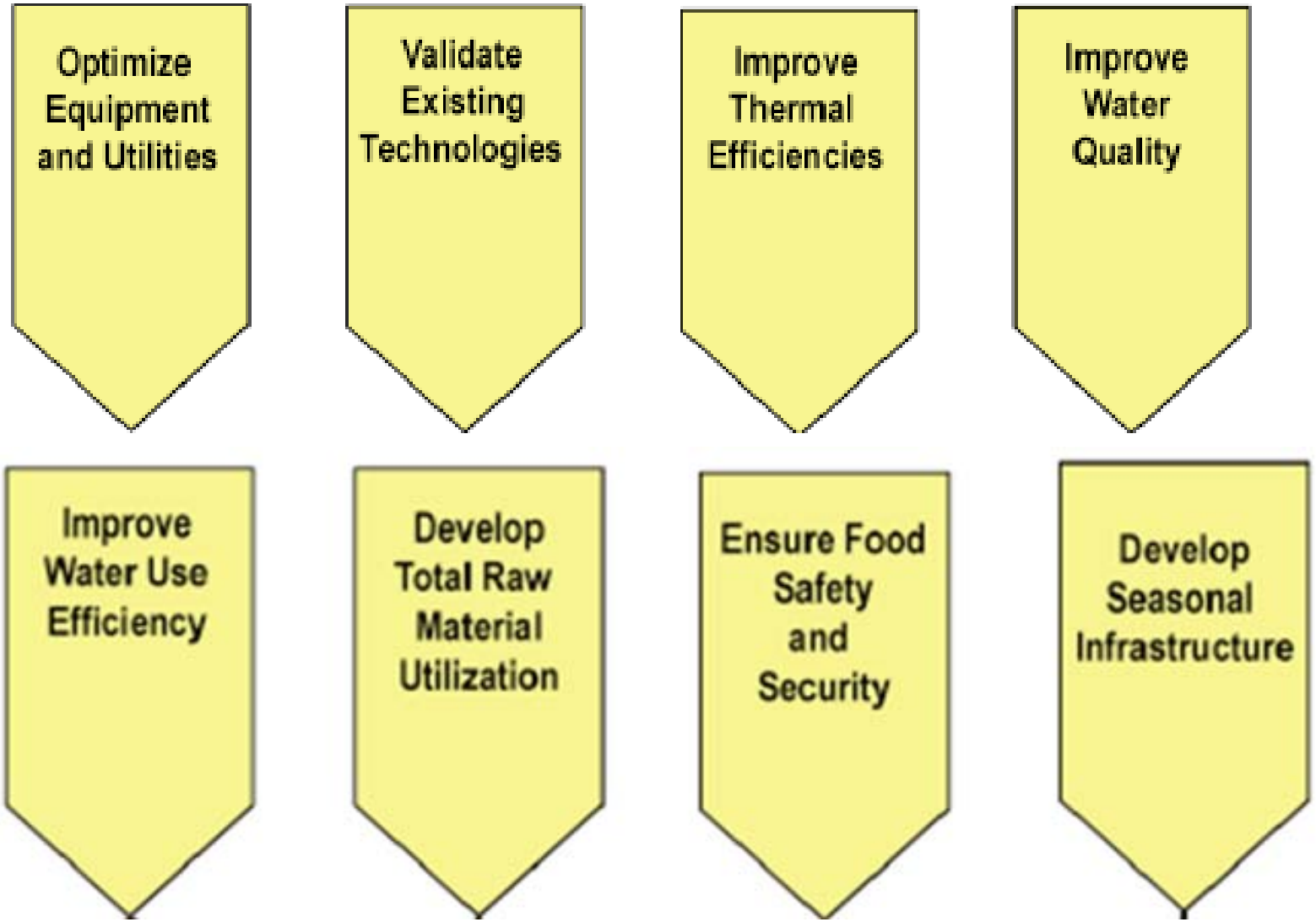
Table 5: Estimated Distribution of Energy (%) within Major Food Processing Sectors in California

Food Processing Wastewater

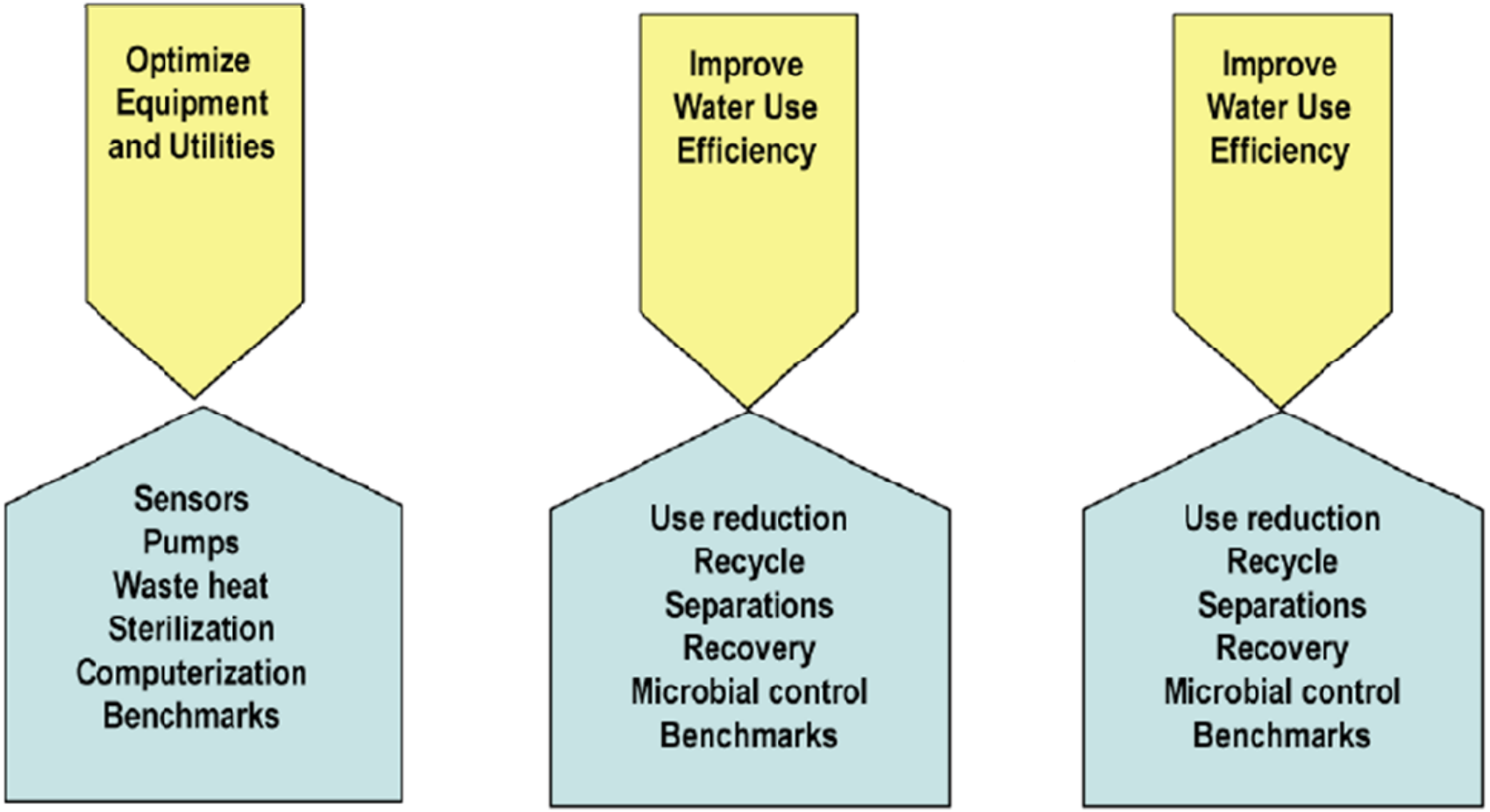
- Fruit, vegetables and wine
  - 88% water used in operations becomes effluent

Food Processing Sector	Total Water Discharge (Billion Gallons)
Fruits & Vegetables[1]	29
Dairy	
Cheese[2]	2.1
Milk Powder/Butter[3]	1.0
Meat	
Beef[4]	1.0
Poultry[5]	1.2
Wine[6]	2.5

Food Industry Adv. Comm. Priorities



Data & Technology Driven Approach

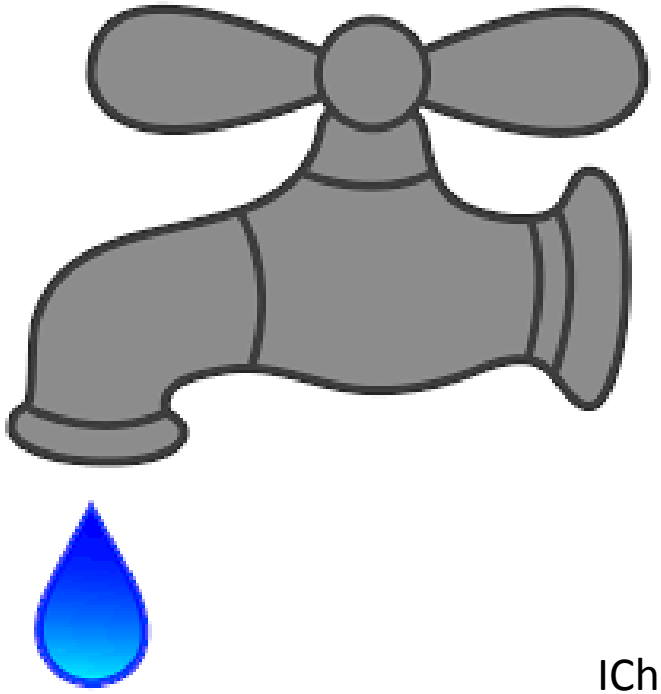


Lower Tech Water Solutions

- Cleaning can account for up to 70% of a factory's water usage
  - Cleaning of processing equipment/plants
  - Cleaning food products
- Conservation strategies
- Optimization of cleaning routines
  - Dry cleaning
  - Controlling waste
- Can save water 20-50% without investing in new and complex strategies

Food Processing Water Solutions

- Reductions of 20–50% possible
  - Based on study in UK
- Reuse of cooling water (25%)
- Fixing water flow and leaks (12%)
- Automatic shut-off (6%)
- Control of overflows (6%)
- Optimizing supply pressure (5%)



Zero Water Factories

- Major companies are investing in research into more effective water conservation
- Drive to ‘zero water’
- The ‘zero water’ concept
  - Does not mean that no water is used
  - Water ‘neutral’ process operations are
- Return of water post process
- Recycled, reused within process unit
- Applying chemical engineering principles to optimize & intensify processes
  - Minimizing water use

Summary

- The food processing industry is an important user of water & power
- Water-energy-food nexus principles are applicable to improving resource management in food processing
- California is facing significant water & energy challenges
  - And has faced them before
- Food Industry Advisory Committee is a clearing house for innovation & practical solutions from industry, government & academia

Summary

- California uses data & technology driven approaches
- Know the system inefficiencies
  - Sensors, metering, data collection
- Systems approach to resolving inefficiencies
  - Capture waste heat, recycle water, fix or replace equipment, use or sell wastes, etc.
- Lower technology water solutions are also available
  - Significant saving in water & energy utilization may be possible with conservation efforts alone

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