Energy-efficient Wastewater Reuse

Richard G. Luthy, Stanford University and the ReNUWIt Team

Main messages

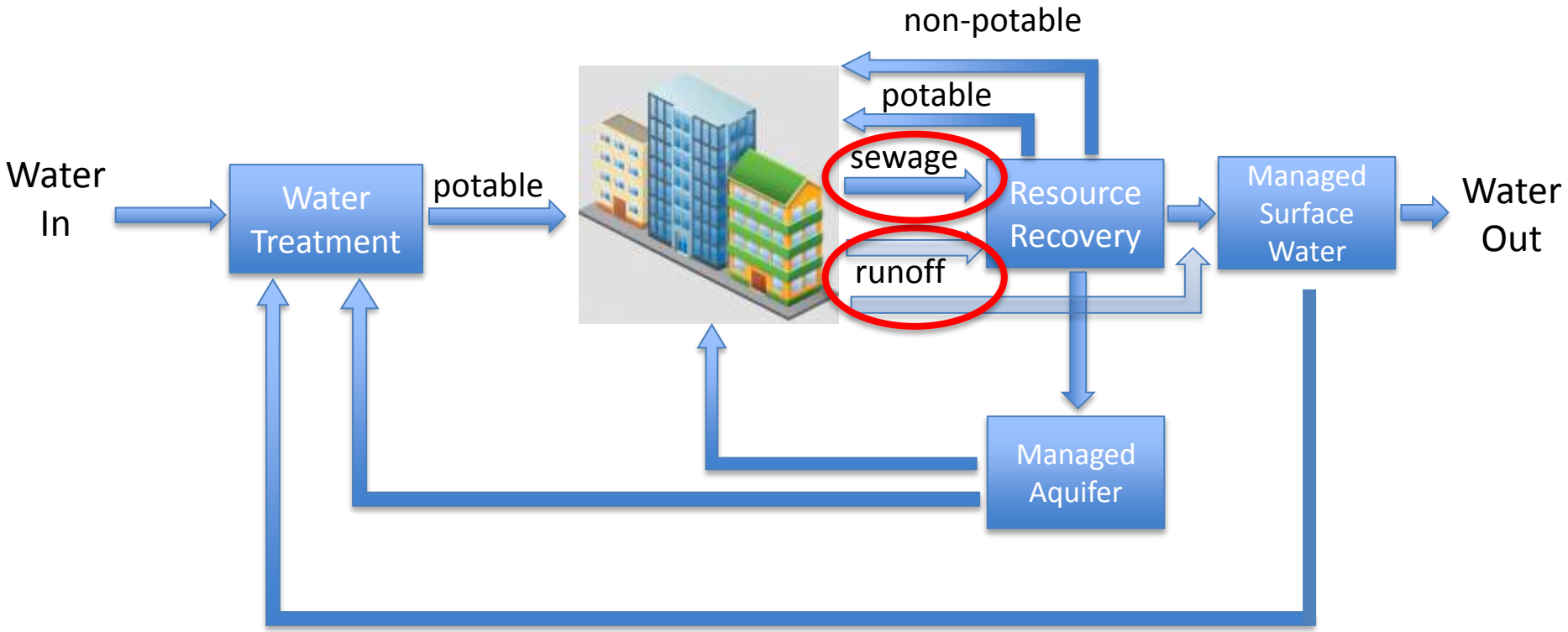
- **Recycling & energy recovery**
  - **Decentralized systems**
  - **New technologies**
  - **Efficient desalination**
- **Demonstrate at test-bed scale**
  - **Assess reliability & control**
  - **Gain acceptance**
- **Systems-level analysis**
  - **Savings & cost analysis**
  - **Scale-up & build out**

Frank Gehrke (chief of snow surveys) and Gov. Jerry Brown

“Measuring” the Sierra snowpack on April 1, 2015

First time that there was no snow to measure

Urban systems for water supply resiliency & energy efficiency



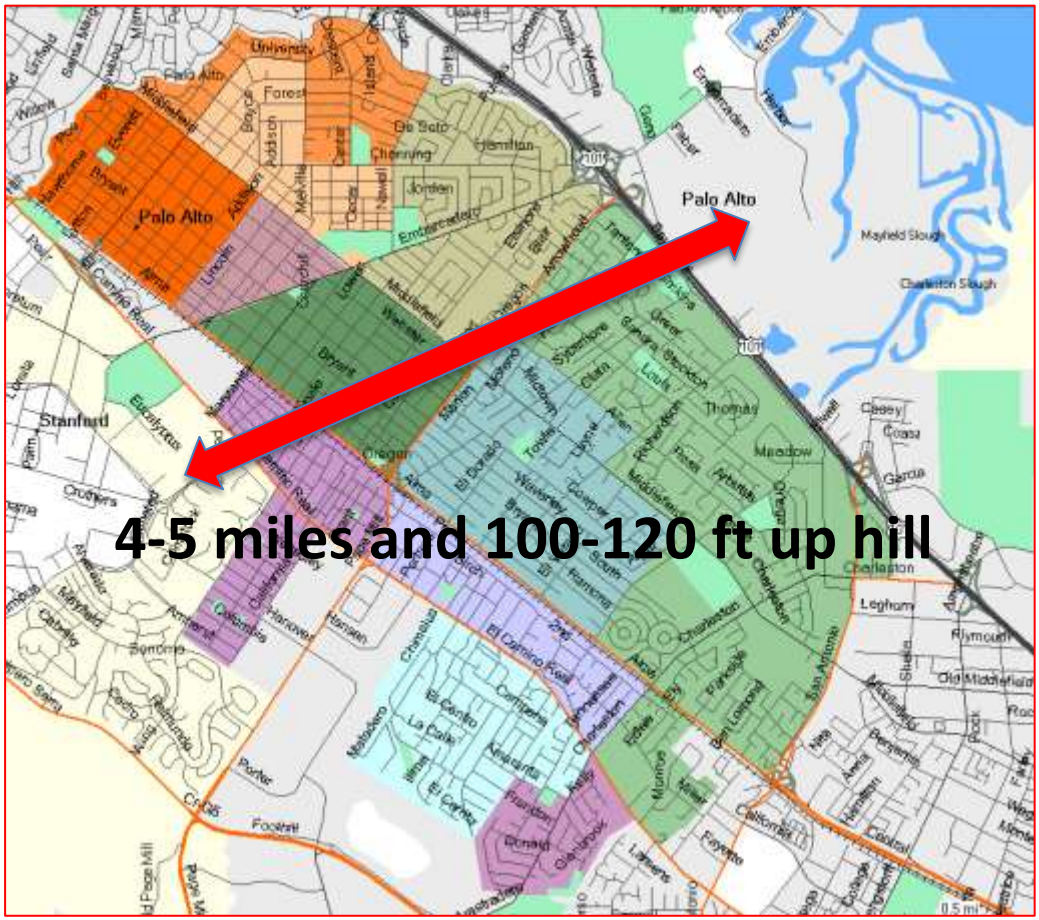
Decentralized water reclamation

- "Satellite" treatment plants
- Working together with centralized treatment
- Hybrid operations for greatest efficiencies

Lee et al., *Environ. Sci. & Tech.,* 47(19), 2013

Decentralized water reclamation

- Avoid pumping water back up hill and save energy
- Avoid cost of reverse pipeline
- Reclaim the water where it's generated and needed

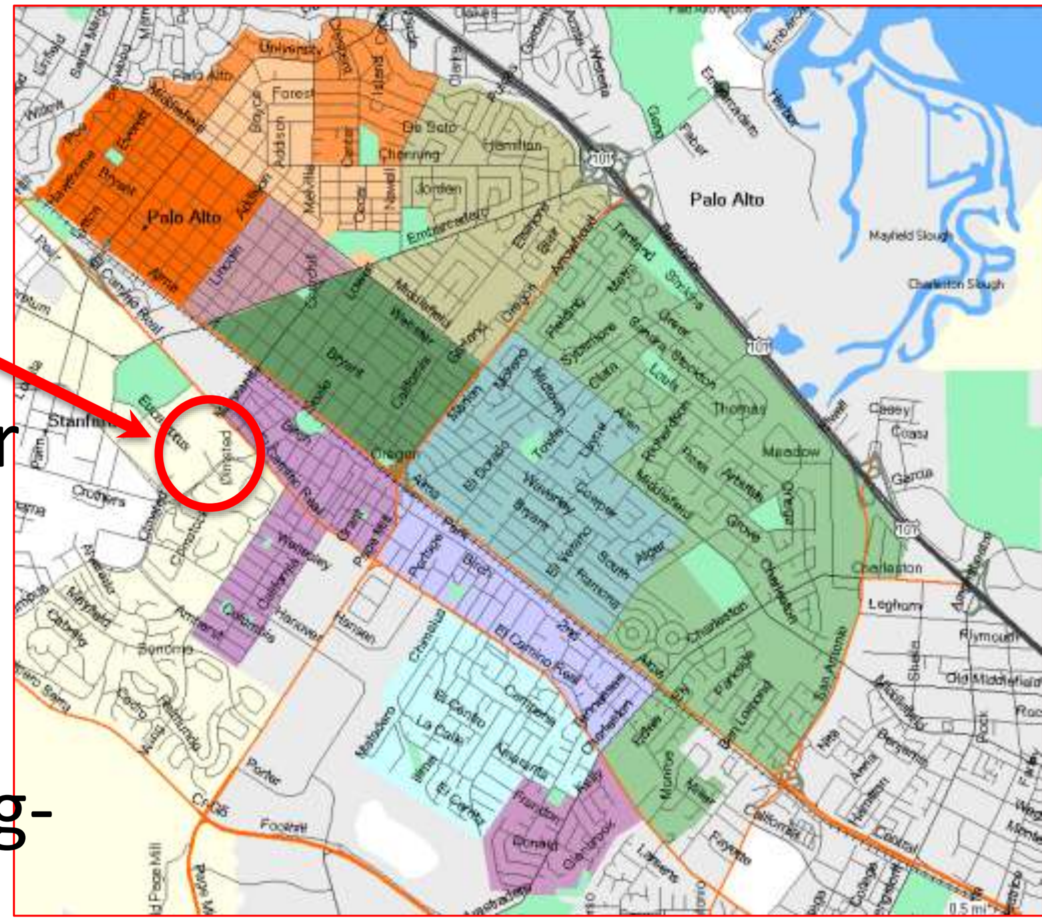


Decentralized water reclamation

- Avoid salt water intrusion
- There's less salt further up in the system
- Less risk of salt build up in soils

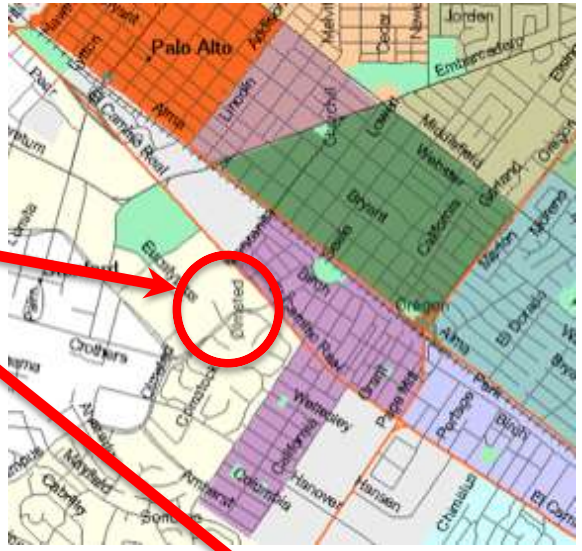
Decentralized water reclamation

- Stanford wastewater at Serra Street approx.
  360 ppm salt
- Palo Alto recycled water approx. **770 ppm salt**
- Stanford wastewater best for irrigation & long-term salt management



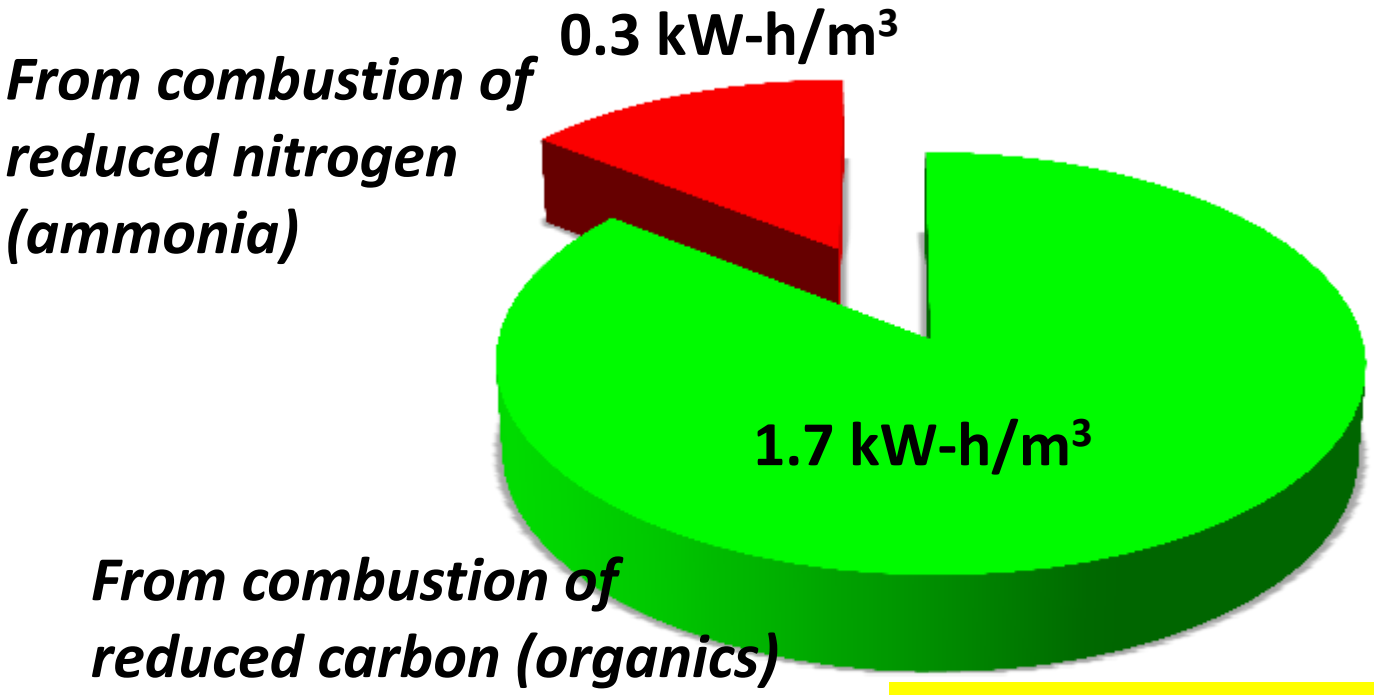
New technologies & water reuse

- Recover energy & water from treatment using new technologies
- Convert organic matter to methane & electricity
- Avoid energy-intensive aeration



Palo Alto Regional Water Quality Control Plant

Innovative water reclamation:
Recover energy from carbon & nitrogen

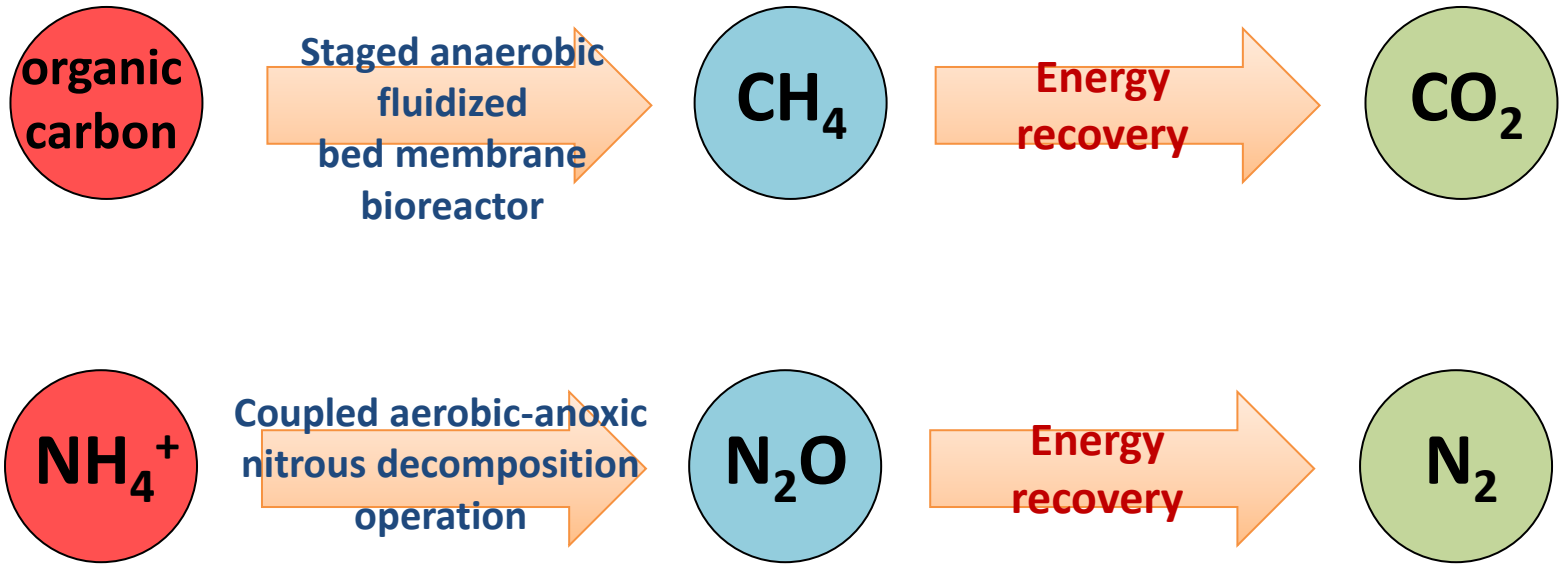


***2 kW-h/m³* potential to reclaim water & energy**

- Recovery energy using new technologies

Innovative water reclamation:

Recovery of energy from carbon & nitrogen

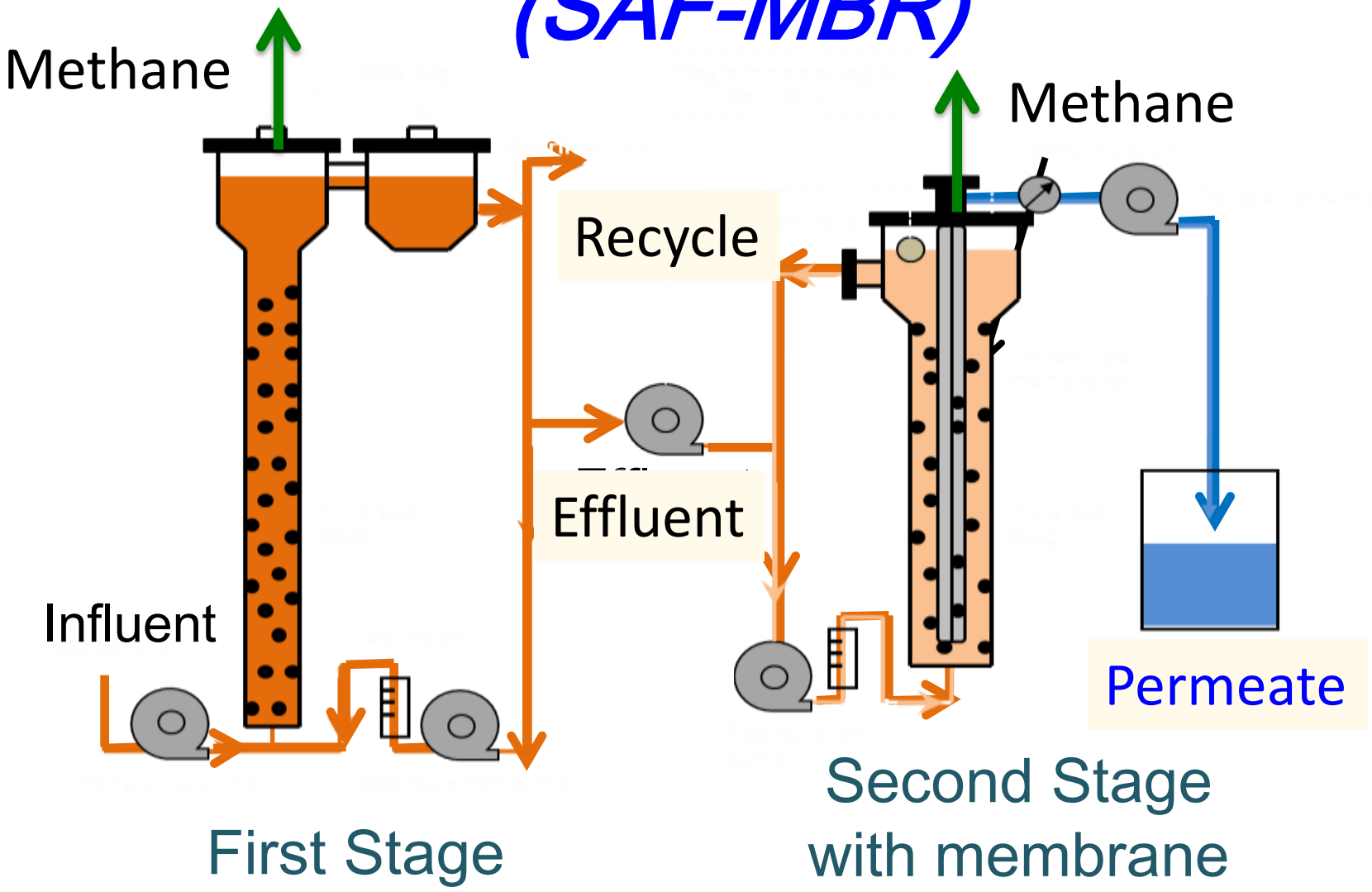


"Green energy" because it's from biomass not fossil fuels

Question

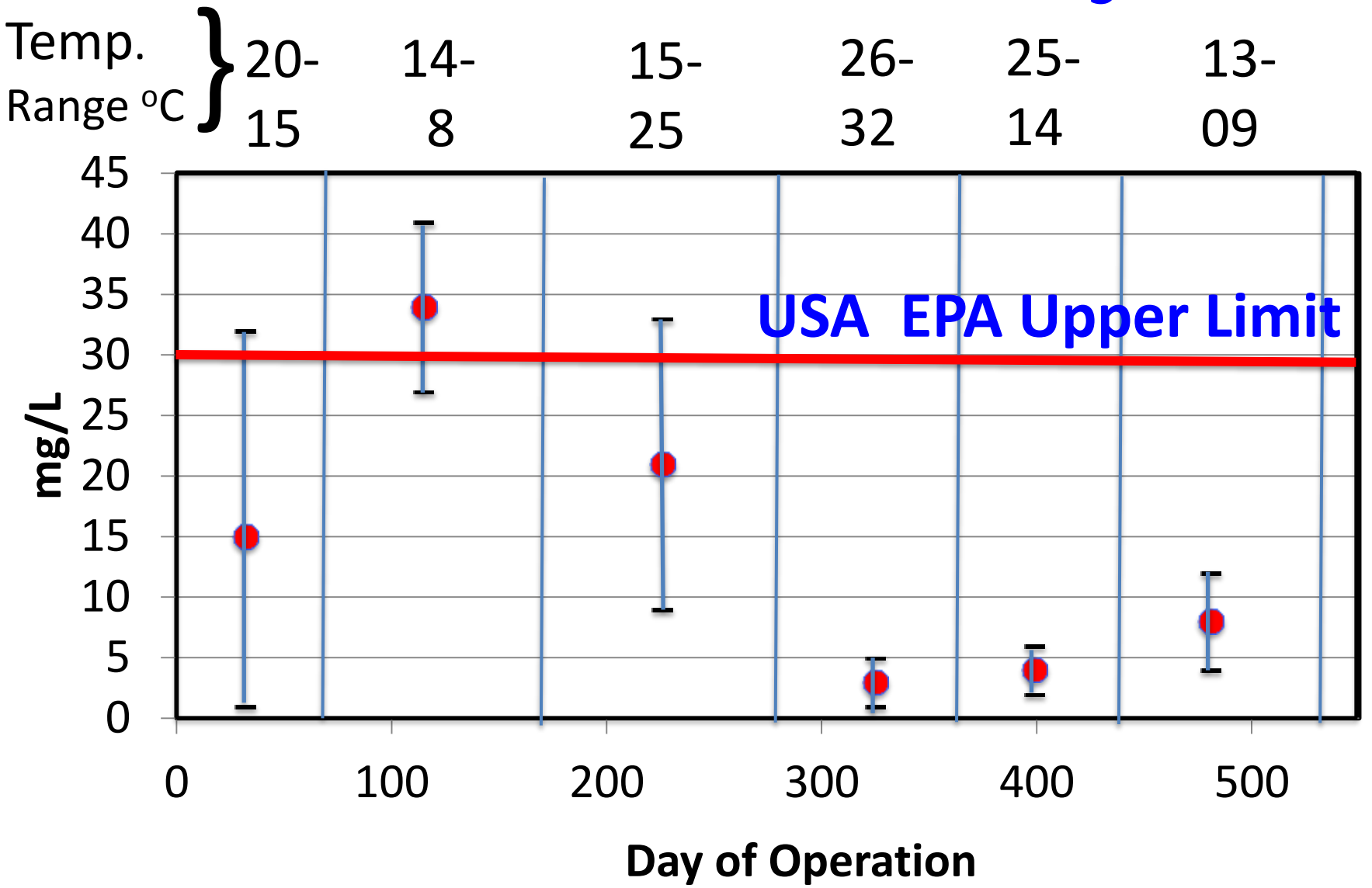
- Can we treat municipal wastewater 100% anaerobically to achieve net energy production while meeting effluent quality standards, and at lower cost than by conventional aerobic treatment ?

Staged Anaerobic Fluidized MBR (SAF-MBR)



Kim et al., Environ. Science & Technology, 45:576(2011)

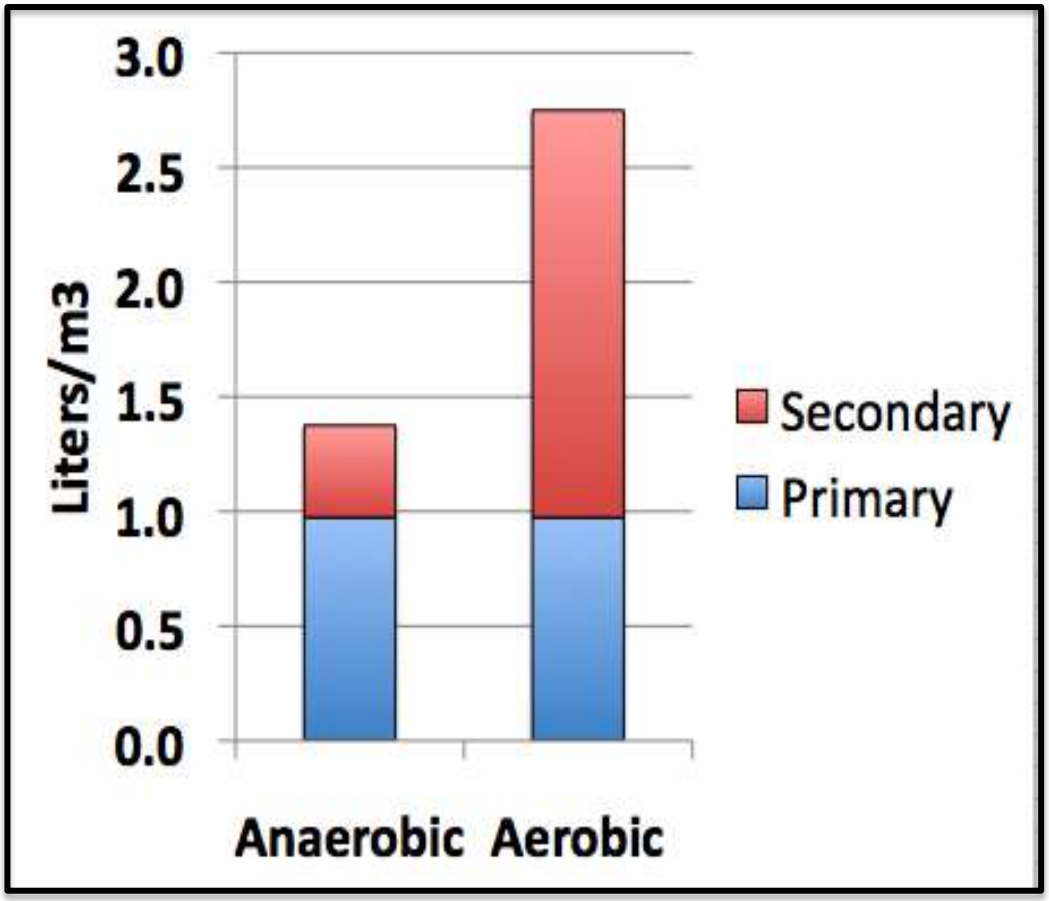
SAF-MBR Effluent BOD_5



Shin et al., *Bioresource Technology*, **159**, 95-103 (2014)

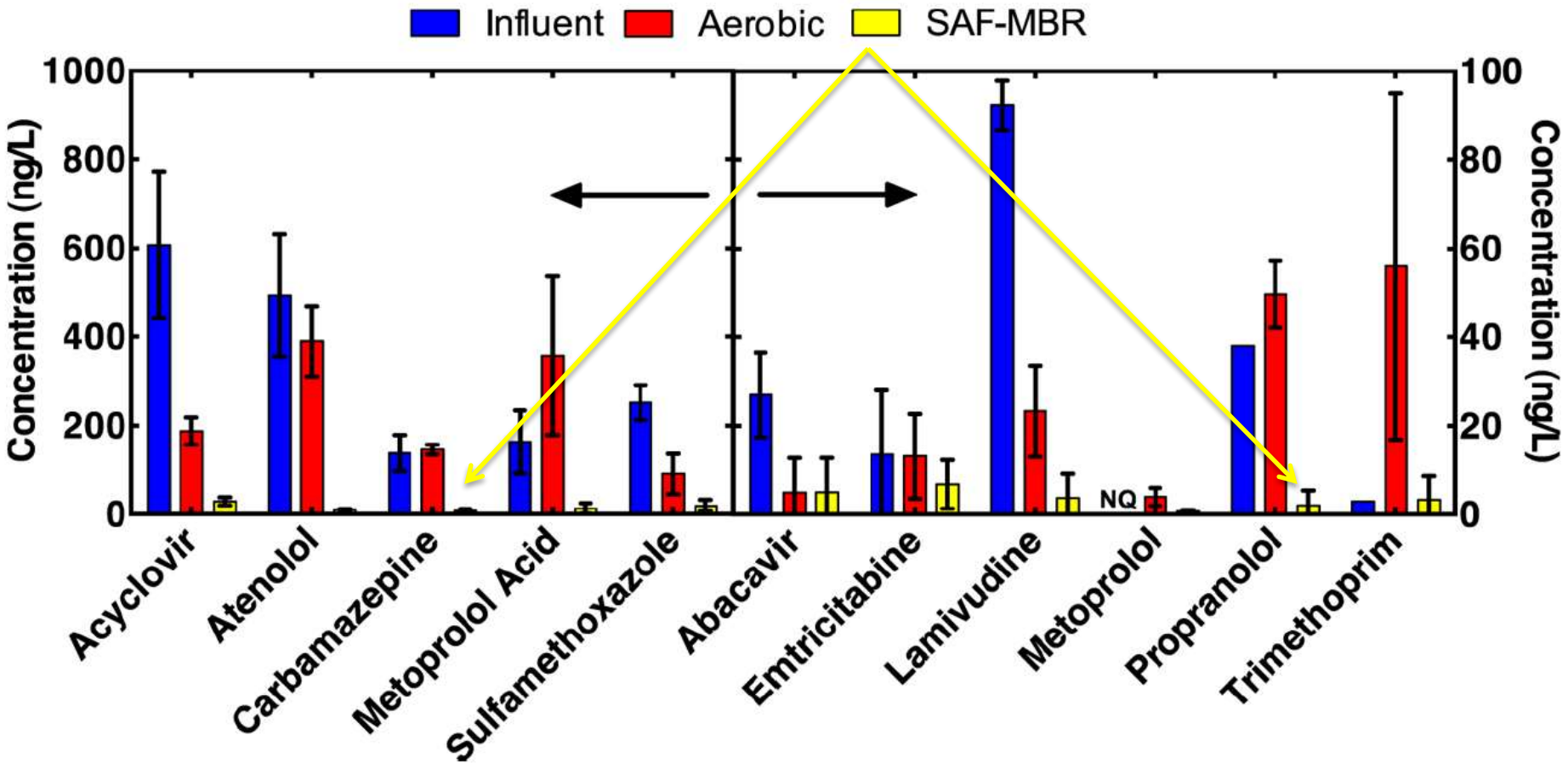
Biosoids Production

0.05 kg VSS/kg COD
and
already digested
and
less than half
that from aerobic
treatment



Shin et al., *Bioresource Technology*, **159**, 95-103 (2014)

Superior removal of pharmaceuticals: new anaerobic system vs aerobic system



McCurry et al., *Environ. Sci. & Technol. Letters*, 1:459, 2014

Innovative water reclamation

This size is believable!

Scale of Wastewater Treatment

- Lab scale: gal/day
- Pilot-scale: 1-10 gal/min
- Full scale: 10-100 gal/second

Pilot-scale is also practical for decentralized or satellite applications

Innovative water reclamation

Codiga Resource Recovery Center

Pilot-scale test bed facility

Wastewater and Waste Organics

Reclaimed Water with Energy Savings

Construction started
April 20, 2015

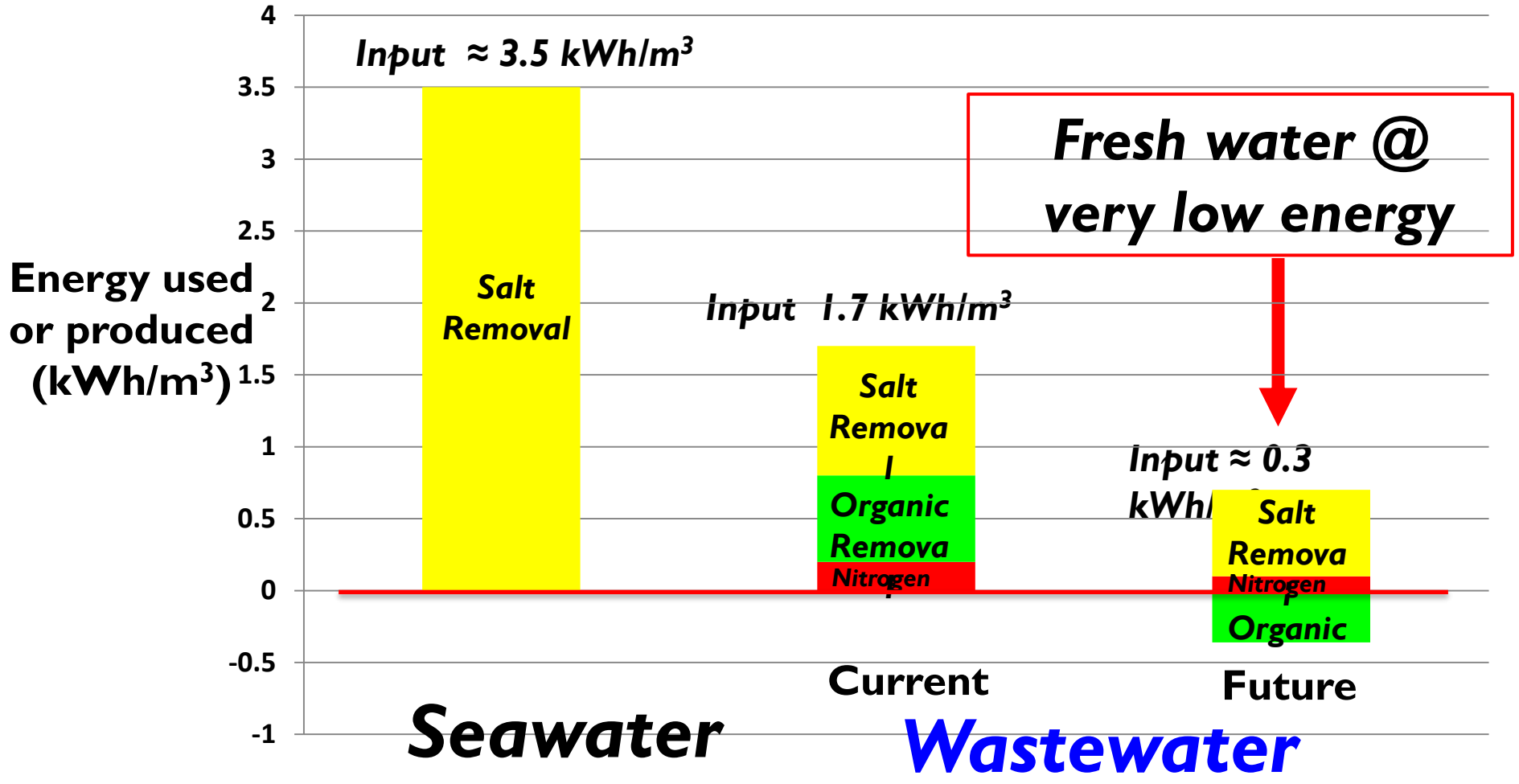
Seawater desalination

50 mgd, Carlsbad, CA
Poseidon
San Diego County Water Authority

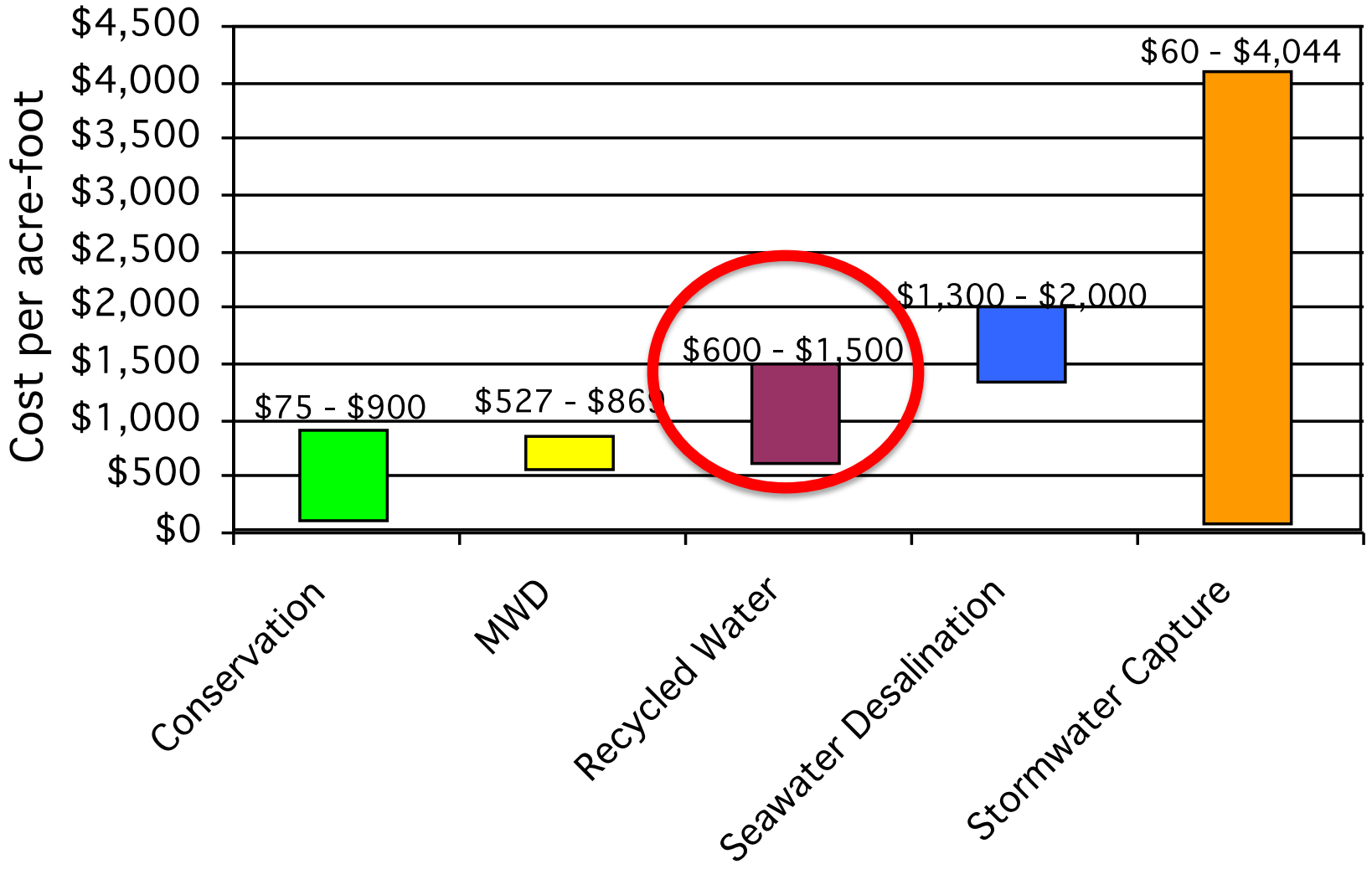
Wastewater desalination

8 mgd, San Jose, CA
Silicon Valley Adv. Water Purification Fac.
Santa Clara Valley Water District

Fresh water recovery



Cost comparison of water supplies

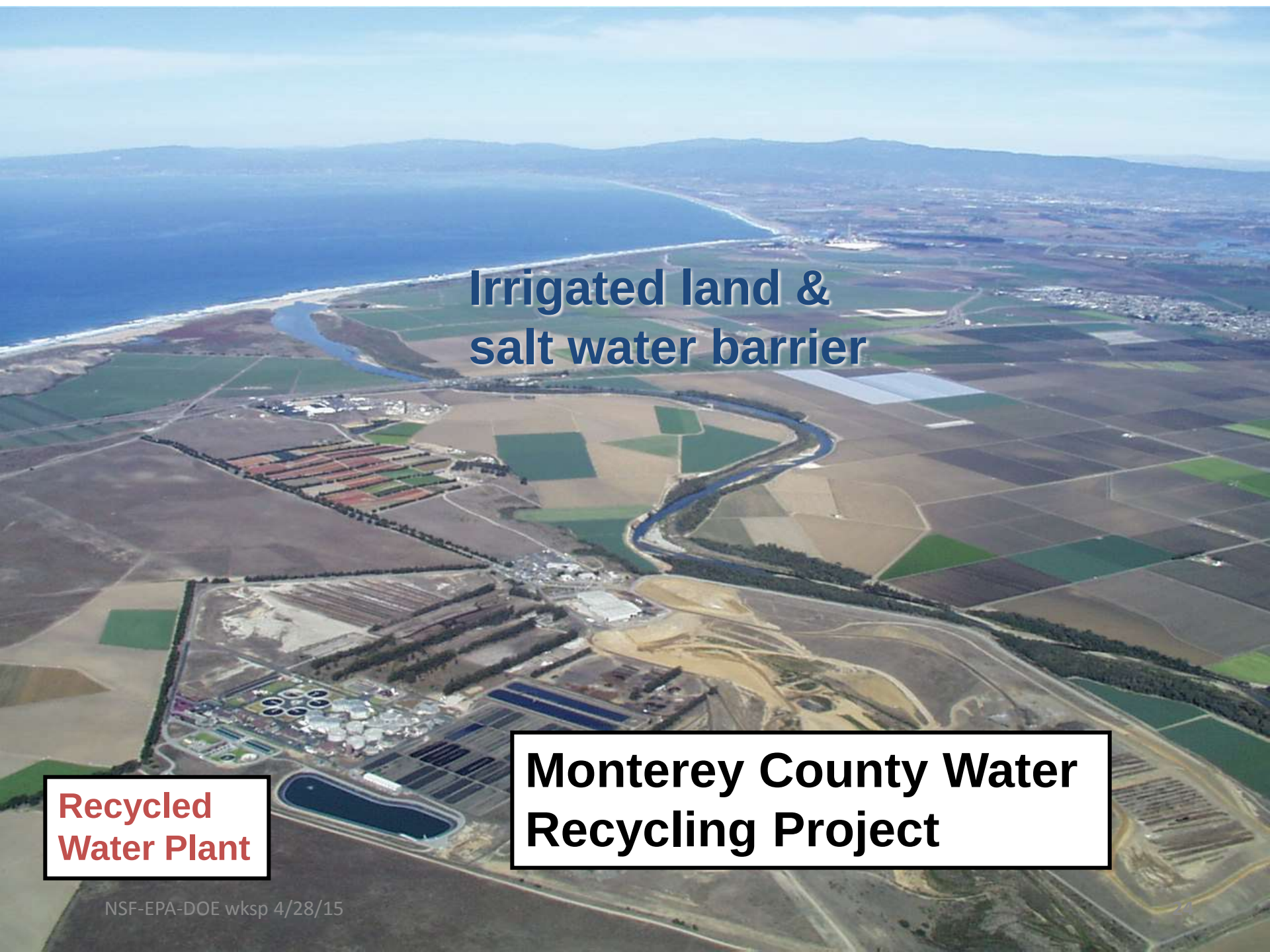


Source: LADWP 2010 Urban Water Management Plan and Water Resources Division

Food-energy-water nexus

Salinas/Monterey/Watsonville

- Case study
- Not part of the State Water Project
- No imported water
- Three growing seasons/year
- Nutrient-rich muni. wastewater
- All-year water supply


Irrigated land &
salt water barrier
Recycled
Water Plant
Monterey County Water
Recycling Project

Monterey Water Reclamation Plant

Take-home messages

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