This presentation premiered at WaterSmart Innovations

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Sustainable Economic Stimulus Requires Decentralized Water Treatment Systems

Stormwater Treatment Wetland, Southwestern USA

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Ecosystems as Infrastructure –
Using Technology to Enhance Ecological Processes

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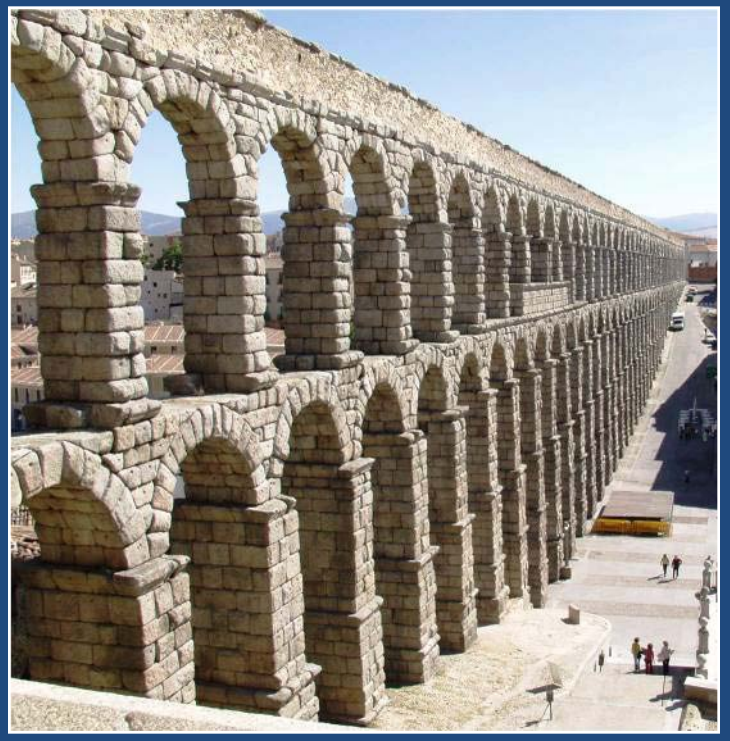
Overview

- A Sustainable Economy is Built on Sustainable Infrastructure
- Centralized Infrastructure has supported growth and health for centuries
- A 21st Century Economy can't rely on 4th Century Concepts
- Decentralized technology can help sustain the human economy and enhance nature
- Consider wastewater as an example



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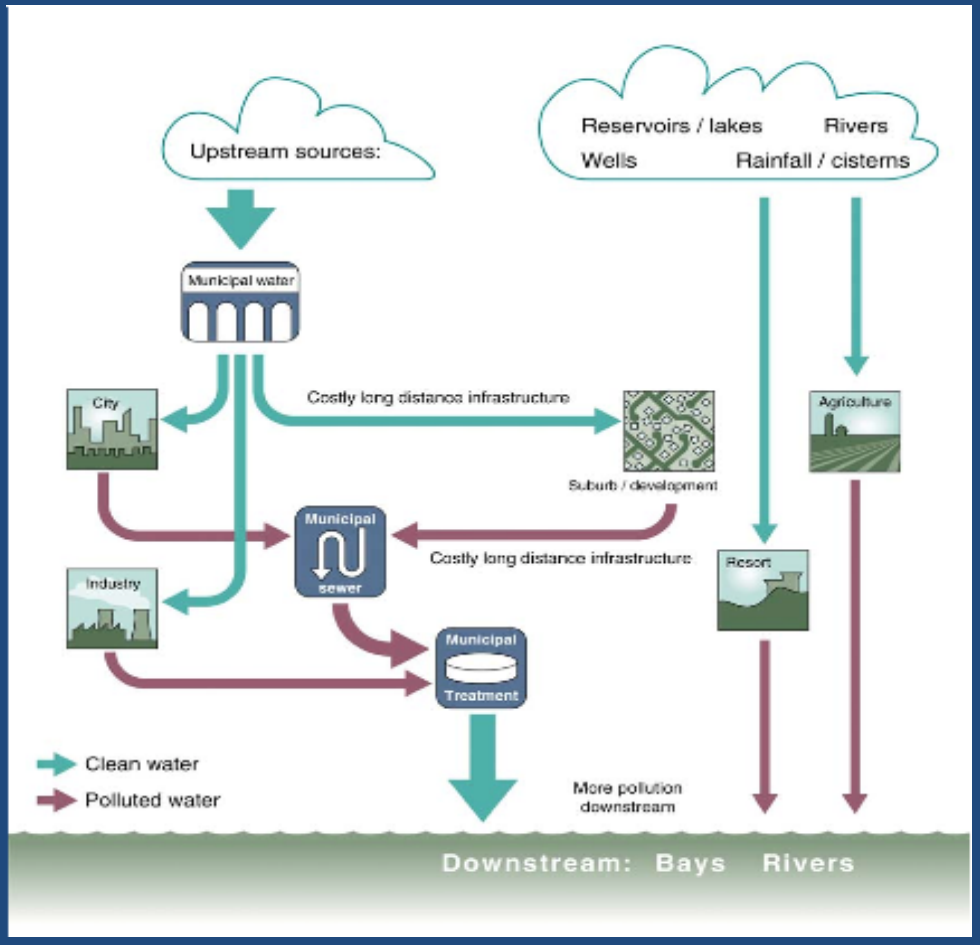
An Unsustainable Future

- Centralization supported
  - Improved health
  - Economic growth
  - Reduced pollution
- Conditions have changed
  - Diminishing returns
  - Maintenance growing exponentially
  - Strained treatment processes
  - Advancing Science and Technology

We are Here:
Technology Replacing Nature



Centralized Model

- Once through
- Technology based
- Energy intensive
- Complex infrastructure
- Extensive GHG emissions
- High maintenance
- Inefficient water use
- Depletes water resources
- Pollutes downstream
- Strains the economy

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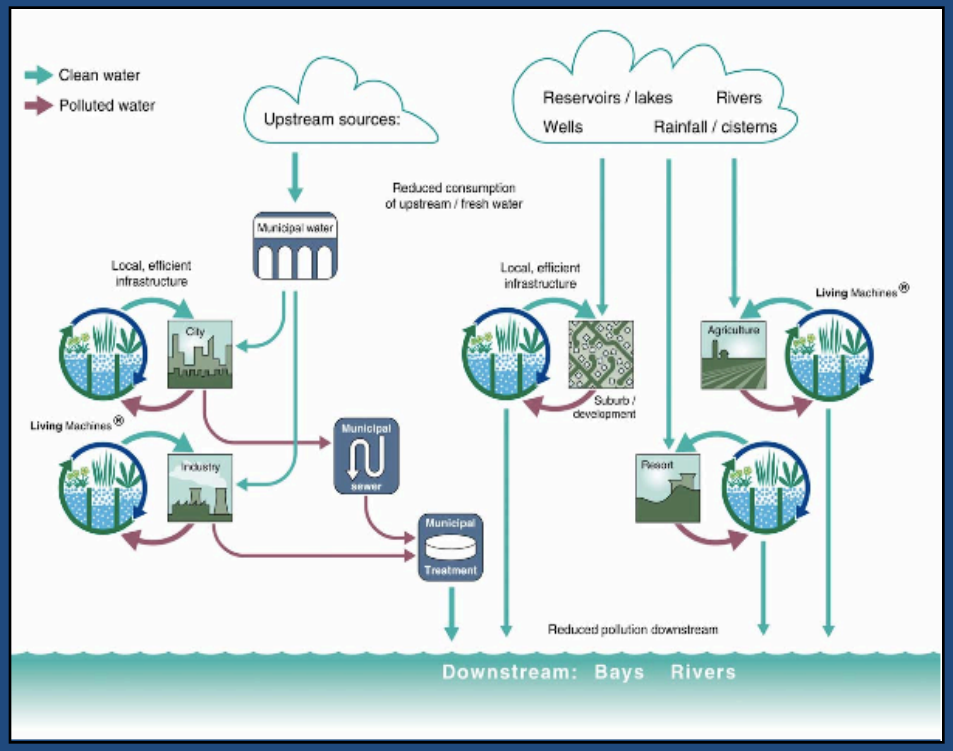
We can be Here:
Technology Enhancing Nature



Decentralized Model

- Extensive water reuse
- Ecologically based
- Low Energy
- Simpler infrastructure
- Minimized GHG emissions
- Lower maintenance
- Efficient water use
- Restores water resources
- Protects downstream
- Sustains the economy

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How Do We Get There?

- Rehabilitate and extend infrastructure life
- Decentralize new construction
- Apply ecological technology and systems approaches
- Integrate with other economic activity

5,000 gpd Living Machine® system, Big Sur, CA

Rehabilitate and extend life of critical infrastructure

Evolutionary

- Build on framework of existing functioning infrastructure
- Rehabilitate to extend life
- Reduce loads with decentralized technologies
  - New construction
  - Replacement and Rehab

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Decentralize New Construction

Decentralized Means:

- Miniaturized
- Diverse, localized/onsite
- Water reused near source
- Modular system construction
- Improved safety, security
- Regional resilience

Animal Shelter, Southwest USA, 30,000 gpd

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Apply Ecological Technology

- Use productive natural treatment processes
- Recycle/reuse water
- Integrate with local water cycles
- Contain/convert pollution
- Fractal ecological systems approach to:
  - Specific treatment technology
  - Regional water systems

25,000 gpd Tidal Flow® Wetland at a School in Southern USA

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Integrate with other economic activity

Evaluate in a broader framework

- Life Cycle Economics
- Energy Effectiveness
- GHG Impacts
- Creation of Livelihoods
- Creation of Businesses
- Strengthening Communities

1,200 gpd Living Machine and AC condensate harvesting system inside office building

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Managing the Transition

Quality, Safety, and Consistency

- Uniform performance standards
- Alternative ownership/management structures
- Technical oversight
- Modified funding programs & tax incentives
- Formal performance measurement

200,000 gpd Living Machine® system, Zoo in Europe

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Managing the Transition (continued)

Innovation in Methods and Structures

- Advanced ecological treatment technology
- New modeling tools & control technology
- New performance measurement algorithms
- Ongoing RD&D

5,000 gpd Living Machine® at a School in Northern USA

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An Example Ecological Treatment System

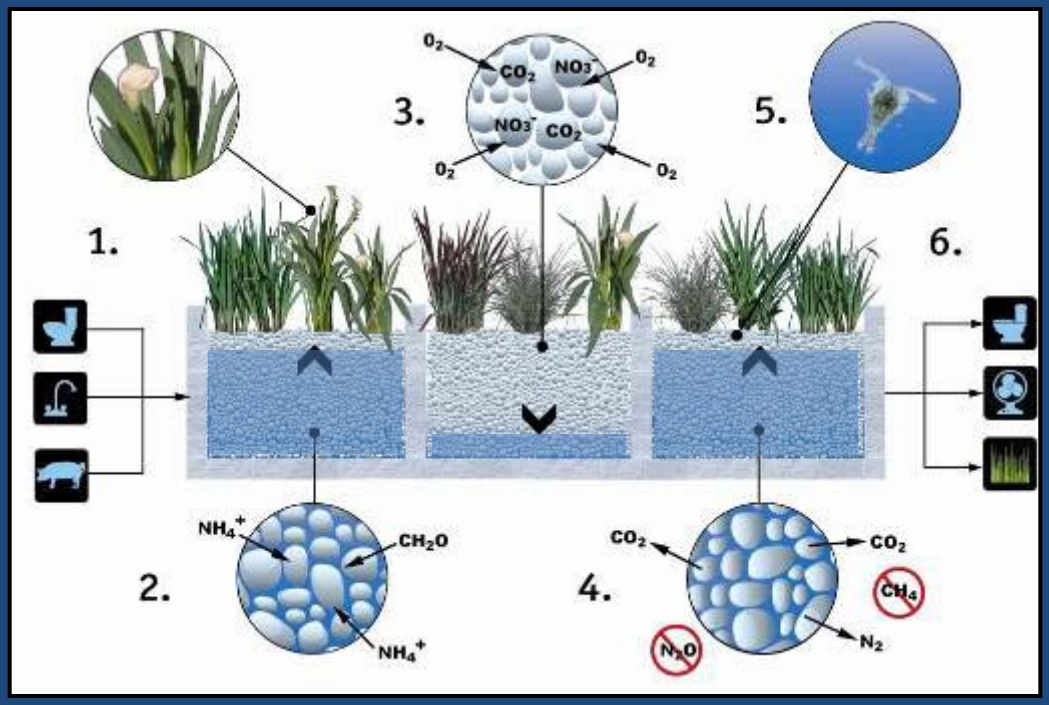
The Living Machine® Tidal Wetland Technology

- Ecologically sound, aesthetic
- Treats blackwater to produce high quality, reusable water
- Small footprint
- Competitive cost & Low maintenance
- Low GHG Emissions
- Broad regulatory approval
- Low energy consumption
- Eligible for LEED credits
- Crop production potential

Office Building, Florida 1,200 gpd

Living Machine® Systems
How Do they Work?

1. Engineered systems – packed bed with extensive biofilm surface
2. When the cell fills carbohydrates and ammonia attach
3. Oxygen fills the cell as it drains and converts ammonia to nitrate and carbohydrates to CO_2
4. Water fills the cell and nitrate becomes N_2 gas and remaining carbohydrates are removed.
5. A complex micro food chain consumes remaining biofilms



6. Treated water can be reused for irrigation, process water, toilet flushing, etc.

Living Machine® Systems

Already Part of the Transition

- Reducing loads on existing infrastructure
- Decentralized, modular new construction
- Applying ecological technology and systems approaches
- Integrating with other economic activity

30,000 gpd Living Machine® system, Southeast USA

Summary

We've been here:

Technology Replacing Nature

What's happening now:

Technology Enhancing Nature

Esalen Living Machine, Big Sur, CA, 5000 gpd

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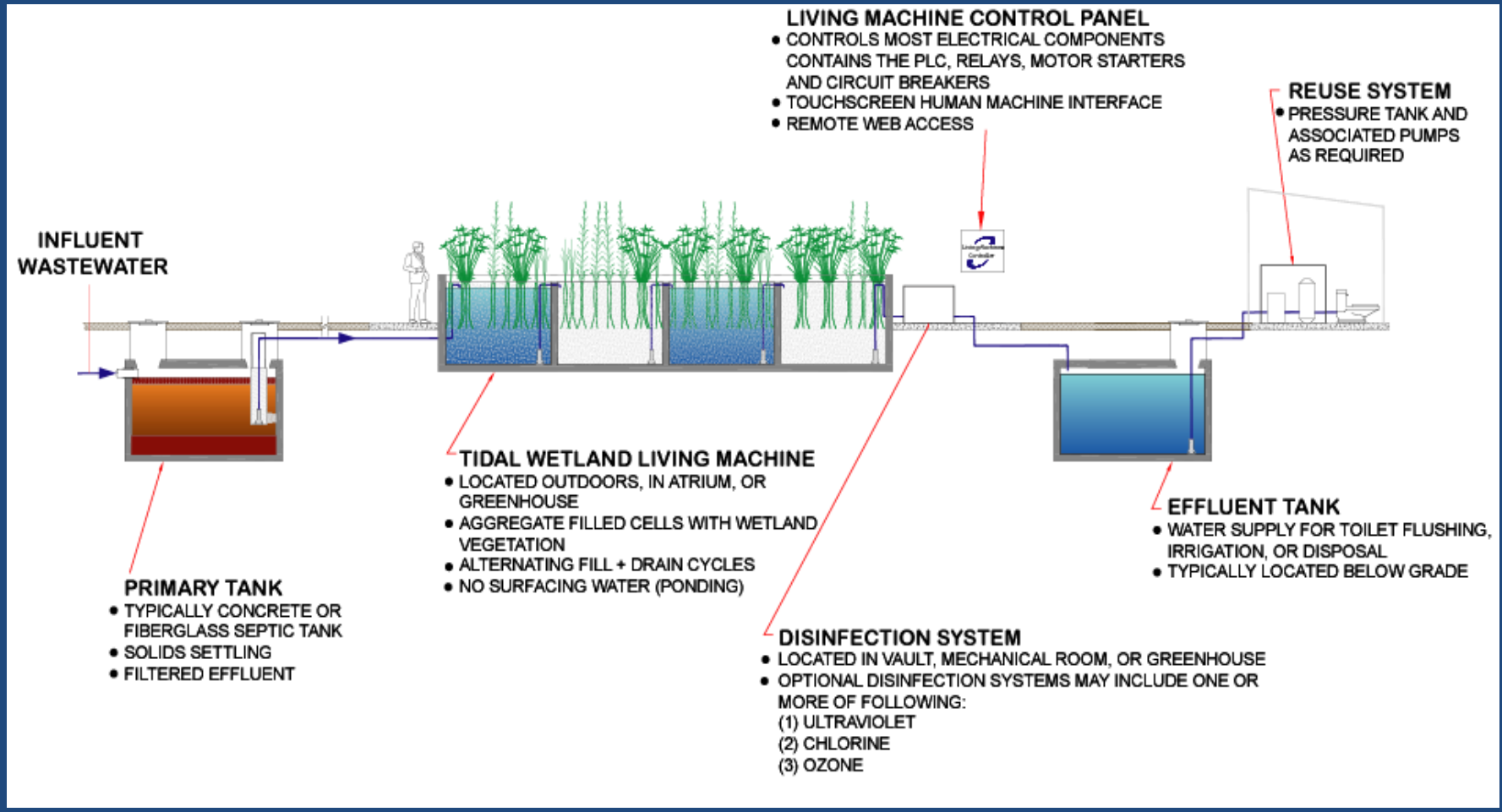
Living Machine® Systems



Living Machine®
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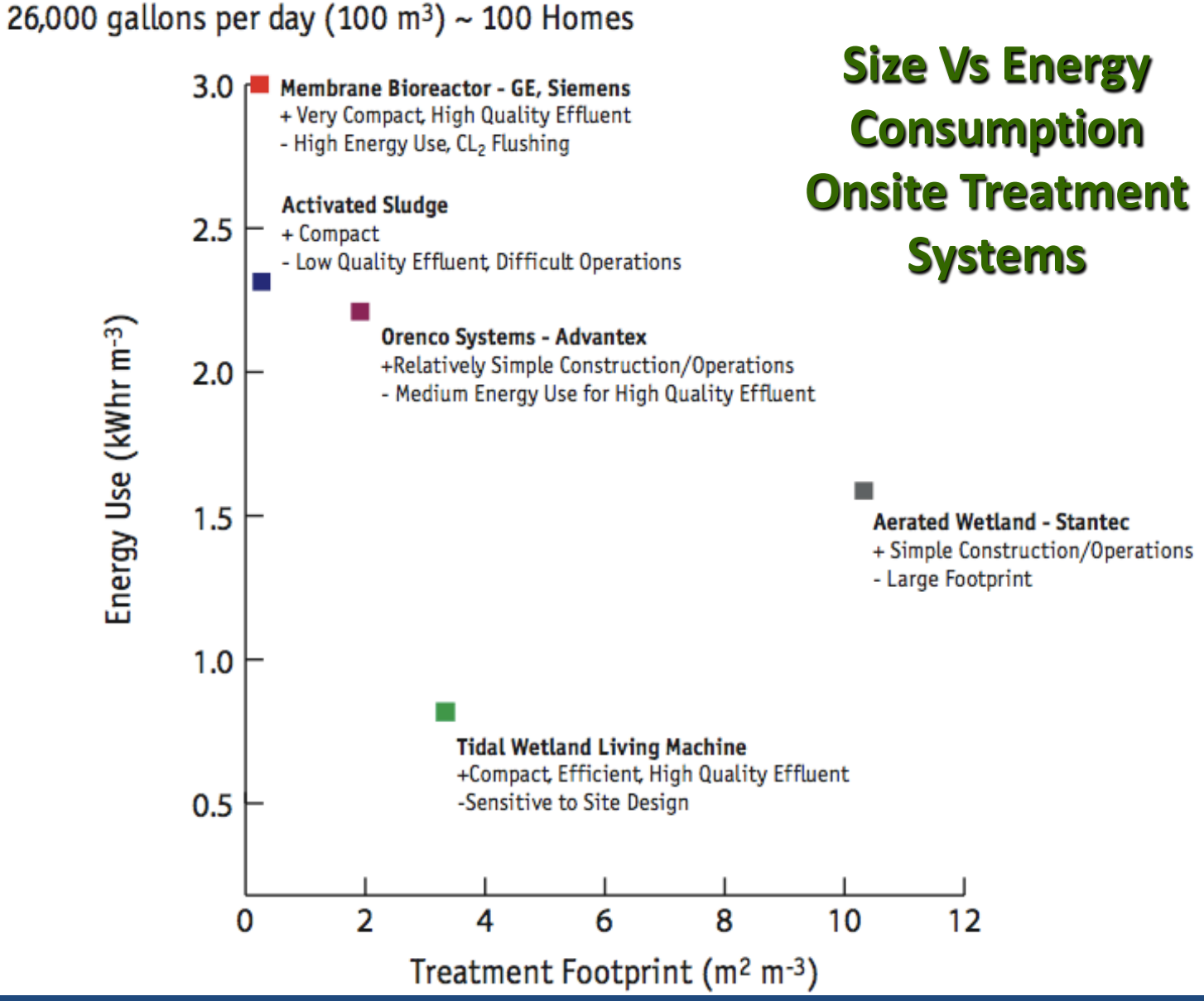
Size Vs Energy Consumption Onsite Treatment Systems



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Ecological Treatment

Example Applications

Housing Developments	• Build-out of scalable capacity as needed • Water reuse for landscaping or common areas • Avoids connection fees, long distance pumping
Agriculture	• Treatment of CAFO wastewater • Treatment of food processing wastewater • Water reuse for irrigation and process water
Schools	• Functional, economic and educational • Water reuse for landscaping, toilet flushing or irrigation
Hotels / Resorts	• Green Technology, cost-effective, aesthetic feature • Water reuse for landscaping, toilet flushing or irrigation
Municipal Wastewater	• Reduces system overload and expansion need • Promotes local water conservation and reuse • Allows ‘sewer mining’

Summary

- Invests in 21st Century Infrastructure
- Applies Ecological processes
- Reduces energy consumption
- Reduces GHG significantly
- Creates local employment
- Provides a community asset and business opportunities
- Creates educational opportunities

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Types of Ecological Technologies

- Rainwater harvesting
- Stormwater wetlands
- Living Machine® wastewater treatment
- Sewer mining
- AC Condensate harvesting
- Hydroponic reactors
- Water efficiency measures
- Watershed protection
- Water reuse
- Permeable pavements
- Etc.

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21st Century Infrastructure Strategies for Ecological Decentralized Systems

21st Century Infrastructure	Ecological Decentralized Reuse
Rehabilitate and extend the life of current critical infrastructure	Reduces load growth on existing treatment systems
Shift to more **decentralized** technologies	Provides local, onsite solution with modular, miniaturized technology
Utilize **ecological** processes	Adapts and enhances tidal estuarine ecosystem
Close material and energy cycles	Promotes water reuse; no waste stream, toxic chemicals, or GHG emissions
Increase in efficiency of energy and water use	Reduces energy and water consumption
Integrate planning and design of infrastructure systems	Supports comprehensive water planning, energy conservation, agriculture, GHG reduction, security, etc.

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