CTCN
CLIMATE TECHNOLOGY CENTRE & NETWORK

Solar powered, low-complexity solutions for decentralized wastewater treatment

UNEP UNIDO

The Climate Technology Centre and Network

- Operational arm of the UNFCCC Technology Mechanism
- Consortium of organizations from all regions + Network
- Mission to stimulate technology cooperation and enhance the development and deployment of technologies in developing countries
- Technologies include any equipment, technique, knowledge and skill needed for reducing greenhouse gas emissions and for adapting to climate change effects
- Core services include:
    - Technical assistance to developing countries

CTCN Technical Assistance

Support to remove barriers to technology transfer (financial, technical, institutional)

- ✓ Identification of needs and prioritization of technology, depending on country context
- ✓ Technical recommendation for design and implementation of technology
- ✓ Feasibility analysis of deploying specific technologies
- ✓ Support to scale up use and identify funding for specific technologies
- ✓ Support legal and policy frameworks

Country-driven

- Any organization from developing countries can express need
- Request endorsed and submitted by the NDE

Fast and easy access to assistance

- User-friendly access: 4-pages submission, in all UN languages
- Appraisal of request within 1-2 weeks and response design within 2-8 weeks

CTCN selects and contracts relevant experts

- Assistance provided through Consortium and Network (value up to 250,000 US$)
- Collaboration with financial organizations to trigger funding

Networking and Collaboration

Join our network!

Access commercial opportunities: respond to competitive bidding for delivery of CTCN technical assistance services

Create connection: network with national decision makers and other network members to expand your partnership opportunities and learn about emerging areas of practice

Increase visibility: broaden your organization or company's global reach, including within UNFCCC framework

Exchange knowledge: keep updated on the latest information and share via the CTCN's online technology portal

Examples of collaboration

- Co-host climate related events
- Twinning arrangements with research institutions
- Engage in new technology projects

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IWT IslandWater TECHNOLOGIES

Solar powered, low-complexity solutions for decentralized wastewater treatment

www.islandwatertech.com

Presentation Overview

1: Introductions

2: Energy-water nexus

3: Decentralized wastewater treatment – advantages and disadvantages

4: Enabling capability of solar powered decentralized infrastructure

5: REGEN – Technology development

6: REGEN – Commercial applications

7: Summary

IslandWater TECHNOLOGIES

1: Introductions

What is Island Water Technologies

- Founded with the goal of developing enabling technologies - self-powered, "smart", self-operating wastewater treatment.
- Two year window of innovation – developed 3 products
- Consultancy services on diverse environmental and technical projects

- http://islandwatertech.com/about/

ClearPod

REGEN™ Renewably Powered Wastewater Treatment

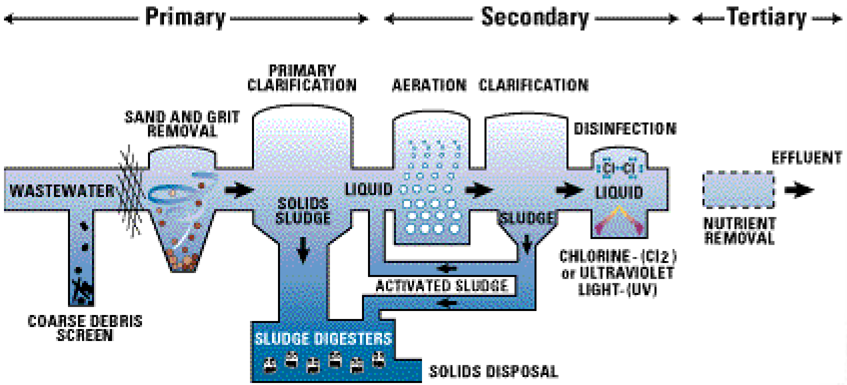
SENTRY-AD™

2: Energy-water nexus

3 – 4% of US electricity is spent on treating and transporting water and wastewater

86.4 million metric tons of CO_2

~ 80% of this is spent on transporting water



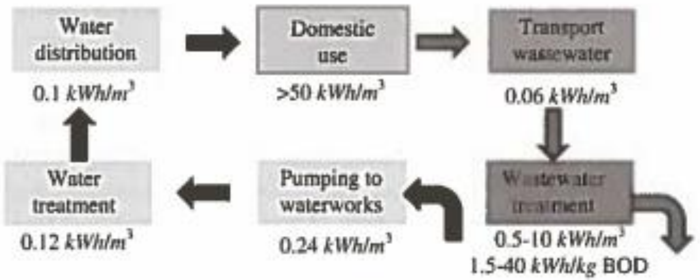
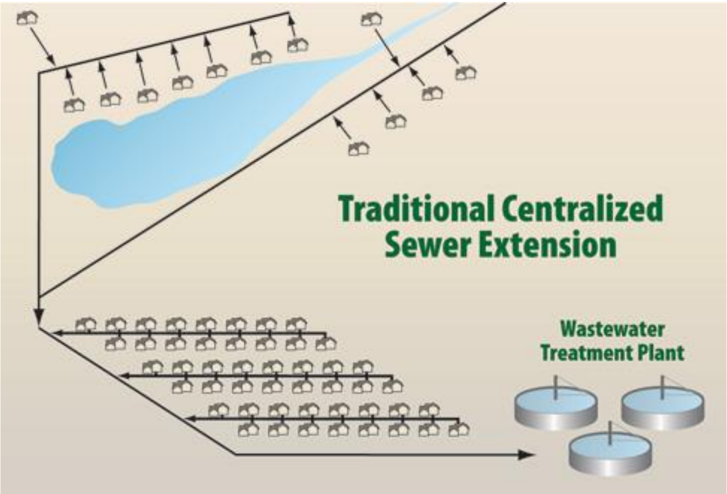


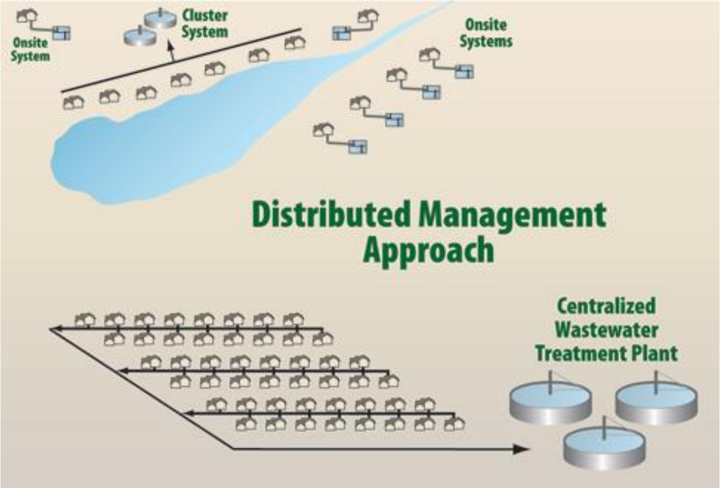
Figure 15.1 The urban water cycle and its energy footprint. *Source*: Swedish data from Lingsten *et al.* (2008).

Decentralized solutions hold inherent advantages over centralized

Saving costs / energy / infrastructure associated with moving waste water

3: Decentralized wastewater treatment





Costing Components $$$$$

CapEx (Piping, wastewater treatment plant)

OpEx (Maintenance of installed infrastructure, energy)

CASE STUDY: Ontario Municipal Benchmarking Initiative (2013)

Operating annual costs for collection of wastewater **$10,013.50/ km**

Total annual costs for collection of wastewater **$17,435.04 / km**

IslandWater TECHNOLOGIES

3: Decentralized wastewater treatment

CENTRALIZED

- High capital cost
- Energy cost associated with moving water
- Long, disruptive construction
- Highly trained operator needed
- Potential for catastrophic failure
- Lack of population awareness

DECENTRALIZED

- Lower capital costs?
- Low / no energy cost for moving water
- Short, less-disruptive construction
- Basic operation skills required
- Failure consequences felt in smaller area
- Local / homeowner awareness

3: Decentralized wastewater treatment

Benefits – Suitable application

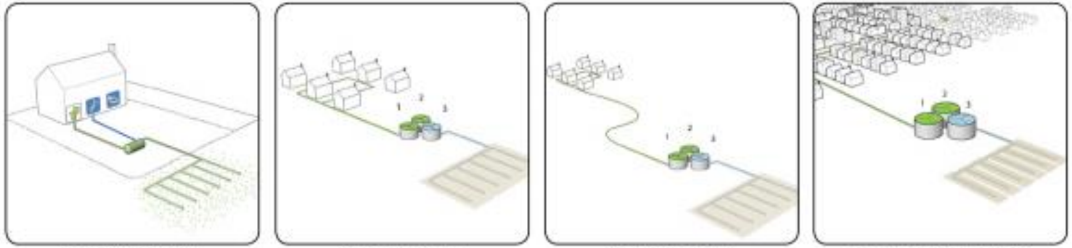
- **Correct technology for the application:** Technology can be targeted to treat the specific WW to required local disposal levels
- **Utilize local resources:** Disposal using local soil complex, ocean, or surface water. Keeps water inside local ecosystem (no cross watershed transport)
- **Stimulate community economic growth, community independence, community choice (complexity, effluent quality, operator requirements, etc.):** Decisions made at the community level, can custom fit appropriate complexity with required performance
- **Easier to implement cutting edge and green technologies:** Lower risk, technologies implemented at appropriate scale, easier market entrance

3: Decentralized wastewater treatment

CAPE COD COMMISSION

CASE STUDY: Regional Wastewater Management Plan
Understanding the Cost Factors of Wastewater Treatment and Disposal - MARCH 2013

FIGURE UCF-1: Sizes and Kinds of Wastewater Treatment



Focused on identifying cost effective nitrogen removal solutions for Cape Cod, MA, USA

Distributed Management Approach

- Individual most favorable when collection pipe per connection exceeded 200ft
- Cluster development is suitable to remote communities removed from sewer connections
- Satellite is most suited when a watershed is more than 5 miles from sewer connection
- Centralized is most suited to high density populations

3: Decentralized wastewater treatment

Current Disadvantages

Decentralized WW treatment can pose advantageous over centralized solutions but standard technology is inadequate!!

Decentralized Disadvantages:

- **Higher energy** (technology dependent, economy of scale)
  - Examples: over aeration due to limited process control
  - Lack of aeration optimization (SOTE)
  - VFDs not really an option with small sized equipment
  - Design for worst day, as no daily operator

- **Variable effluent standards**

- **Legacy of poor performance** (technology dependent)
  - Mainly due to lack of proper maintenance/care

3: Decentralized wastewater treatment

Problem Statement - Energy

Table 15.6 Energy requirement for wastewater treatment in Australia.

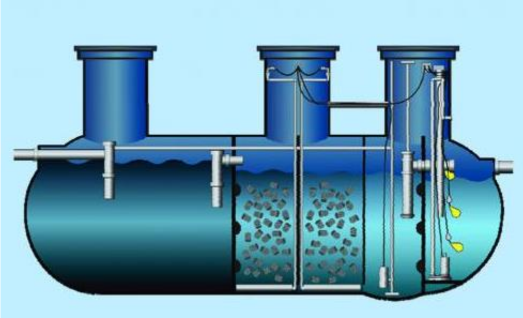
Type of operation	kWh/m³ (min, max)	kWh/m³ (average)
Primary	0.1–0.37	0.22
Biological C removal (incl. primary)	0.26–0.82	0.46
Advanced C, N and P removal	0.39–11	0.90

Sources: Kenway *et al.* (2008); Sydney Water; Brisbane Water.

Decentralized Membrane Based Technology

5 ~ 10 kWh / m3 wastewater

Decentralized Fixed Film Solutions



2 ~ 4 kWh / m3 wastewater

Conventional Centralized Solutions

1 ~ 2 kWh / m3 wastewater

3: Decentralized wastewater treatment

Problem Statement – O&M

Numerous end-users and stakeholders

- Shifting problem statements
- Example: municipal wastewater is the essentially the same everywhere

Lack of O&M

- Lack of interest from owners for maintenance
- Onsite does not mean no maintenance

Can new technologies offer advances to the decentralized space and clearly demonstrate advantages over centralized solutions?

4: Solar powered decentralized wastewater treatment

Benefits and Applications

IslandWater TECHNOLOGIES

4: Solar powered decentralized wastewater treatment

Benefits – Cost and Reliability

- **Infrastructure resiliency:** Grid independence allows wastewater to be treated during grid outages/fluctuations

Hurricane Sandy, 2012 - 11 billion gallons of untreated and partially treated sewage flowed into rivers, bays, canals. New Jersey wastewater treatment plant was pumping millions of gallons of untreated wastewater into the Newark Bay, because the plant had insufficient power to pump out tunnels inundated during the storm.

- **Lower capital costs:** Reduced requirement for electrical distribution system, no additional transformers / grid connections

- **Reduced GHG emissions:** Savings of 3 – 4% of electrical requirements (80% on transport)

4: Solar powered decentralized wastewater treatment

Benefits – Cost and Reliability

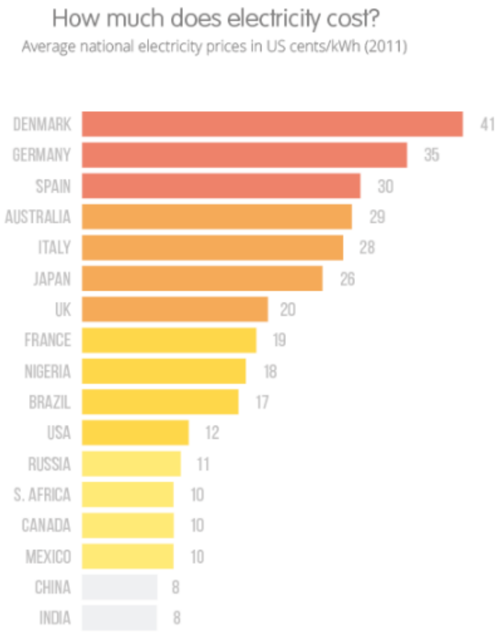
Lower operational costs: High cost of diesel powered generators or electricity

Cost diesel ($/L)

Afghanistan = 1.19
Algeria = 0.16
South Africa = 1.17
South Sudan = 1.98
Kenya = 1.07
Costa Rica = 1.21

*fully burdened costs can be much higher (> $2.50 $/l for remote communities)

http://data.worldbank.org/indicator/EP.PMP.DESL.CD



4: Solar powered, decentralized opportunity – Case Study

Military

600 soldier FOB requires a convoy of 22 trucks per day just to supply fuel and water and haul away wastewater and solid waste.

Burn latrines cost fuel and cause illness

Excessive cost and risk in hauling wastewater

Refugee Camps

Health risk with untreated wastewater
2011 Cholera outbreak in Somalia
2011 Cholera outbreak in DRC

Excessive costs for haulage
Risk to groundwater contamination
Trench latrine / open defecation

Disaster Relief

2014 Cholera outbreak in Haiti (Natural Disaster)

Lower operational costs: High cost of diesel powered generators or electricity in all of these cases

4: Solar powered, decentralized opportunity – Case Study

Costa Rica – Only 4% of the wastewater in the country is treated before being dumped in rivers and other water bodies.

In Costa Rica, 73% of the population uses a traditional septic tank, most sludge collected from septic tank systems is disposed of to waterways. The sanitary sewer system only serves between 20 to 25% of the remainder.

In the Greater Metropolitan Area in San Jose (GAM), > 100,000 m3/day of wastewater is discharged, with only 838 m3/day receiving treatment at one of the 20 sewage treatment systems. 25 of the country's 34 watersheds are contaminated. Most of the discharges are linked to domestic wastewater from toilets, showers, sinks and laundry. (as of 2013)

Current focus – Centralized solution. $45M Los Tajos plant for San Jose

Panama – The Bay of Panama is in a eutrophic state due to wastewater discharge. Only 60% of inhabitants are connected to a sewer line.

Current focus - $516M project to centralize wastewater treatment in Panama City

4: Solar powered decentralized wastewater treatment

SUMMARY

Distributed management approach to wastewater treatment, that incorporates decentralized solutions results in reduced risk and significant economic and environmental benefits. Technology limitations have hindered adoption.

Self-powered, decentralized wastewater treatment solutions have the potential to drastically reduce energy utilization and costs (> 80%) associated with traditional centralized wastewater treatment

Next generation technology solutions should have the following features

- Low complexity
- Modular
- Low-energy
- High performance

Technology Development at Island Water Technologies

ClearPod and REGEN

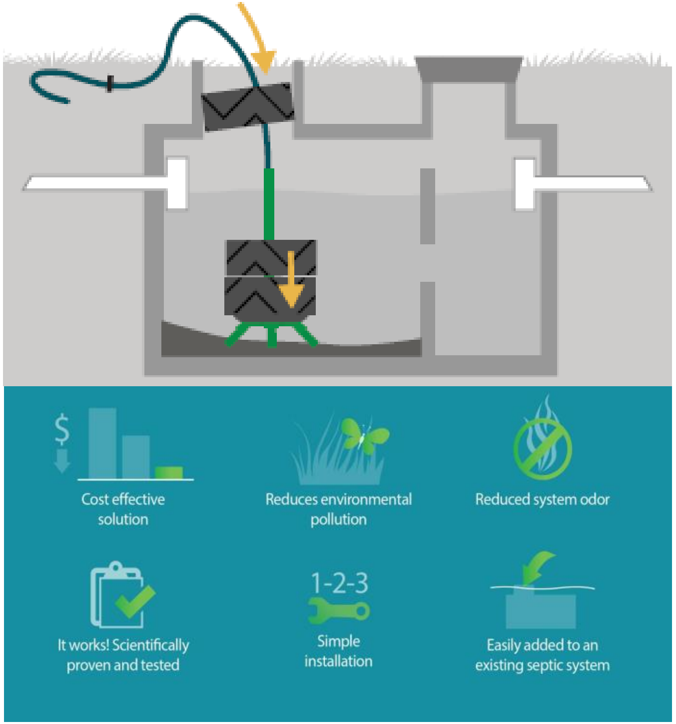
ClearPod

ClearPod

Solution

25% = North American households that rely on septic systems for wastewater treatment

1 Million = # of Septic systems that fail in the U.S. every year



5: REGEN Technology development

Military / Disaster Relief

Remote Mining

Rural Communities

5: REGEN Requirements definition

1: Low complexity
The REGEN process is designed using fixed film wastewater treatment technology
No moving parts, gravity drain process flow

2: Modular
Containerized, packaged design allows for rapid scaling and movement to site

3: Low-energy
Focus on reducing energy cost from process

4: High performance
Identification and development of key components that would allow for high treatment efficiency

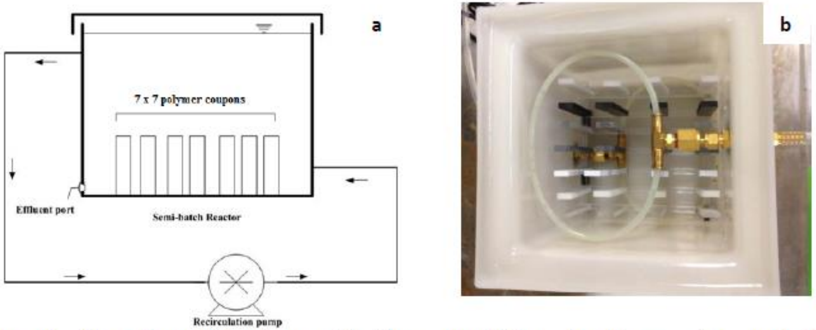
Academic Research and Development

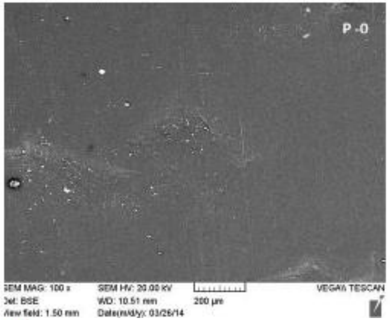
ClearPod and REGEN

5: REGEN Technology development

EFFECT OF SURFACE TREATMENT OF HDPE SUPPORT MEDIA ON BIOFILM ATTACHMENT, GROWTH AND WASTEWATER TREATMENT PERFORMANCE

Fares A. Almomani[1] and Banu Örmeci[2*]





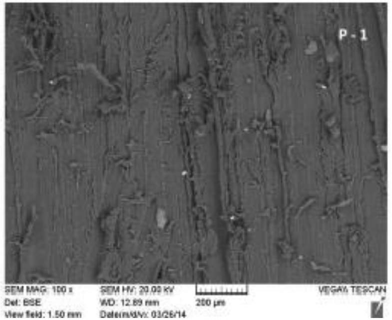
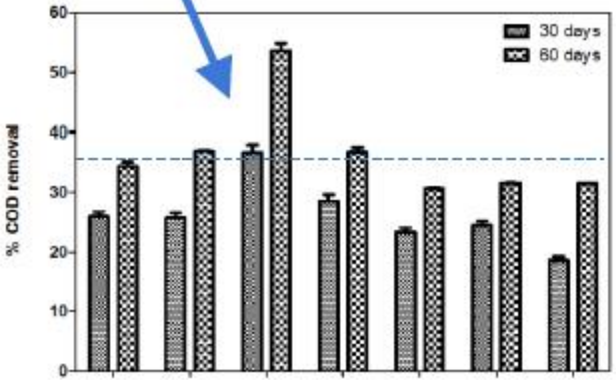


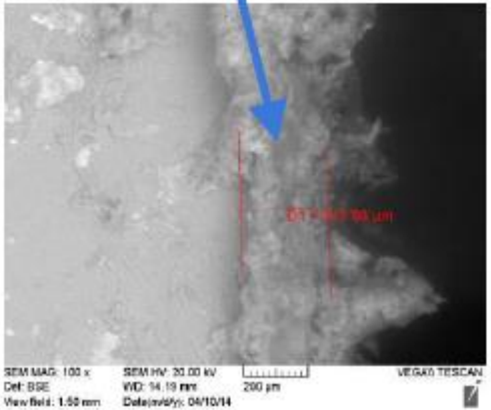
Figure 1: Experimental set-up: (a) flow circulation in the reactor, and (b) internal configuration and the arrangement of the HDPE coupons.

5: REGEN Technology development

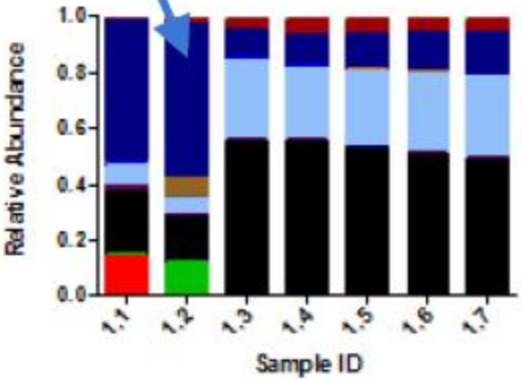
50% increased COD removal



50% increased bio-attachment

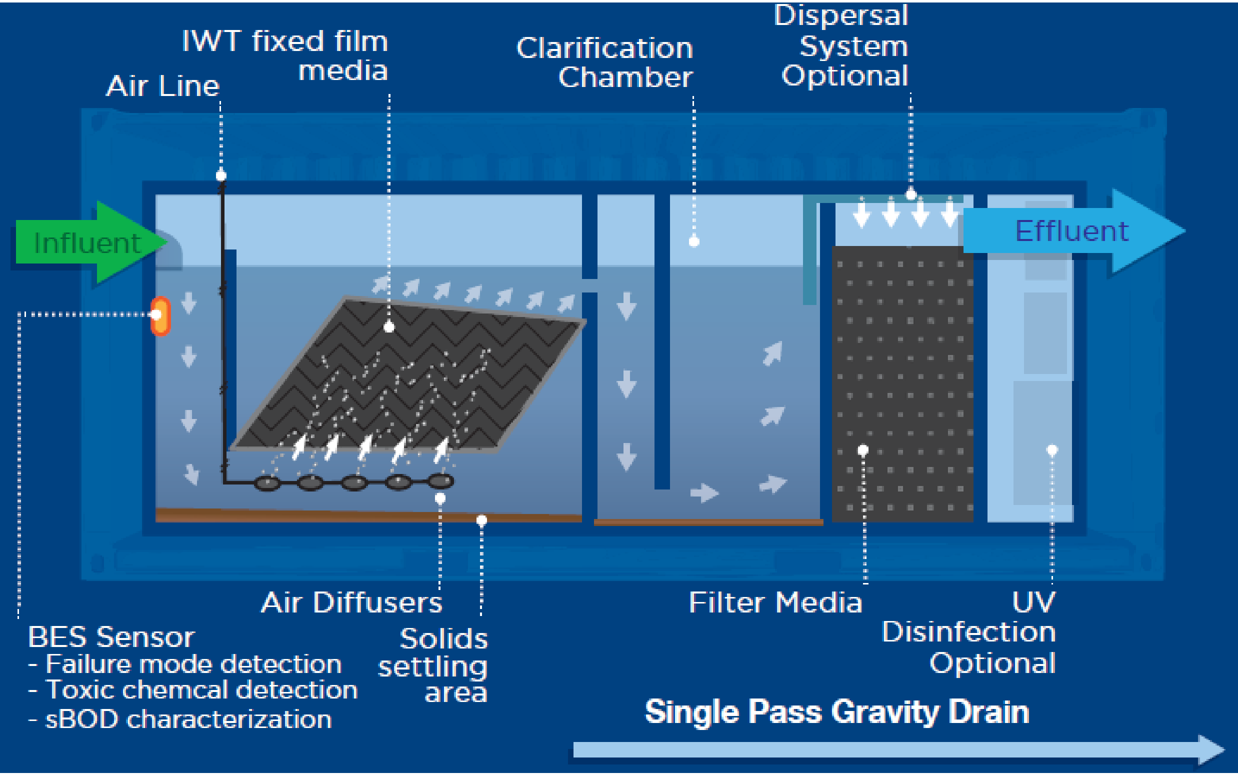


Genetically distinct microbial populations



REGEN Process and Key Components

5: REGEN Technology development

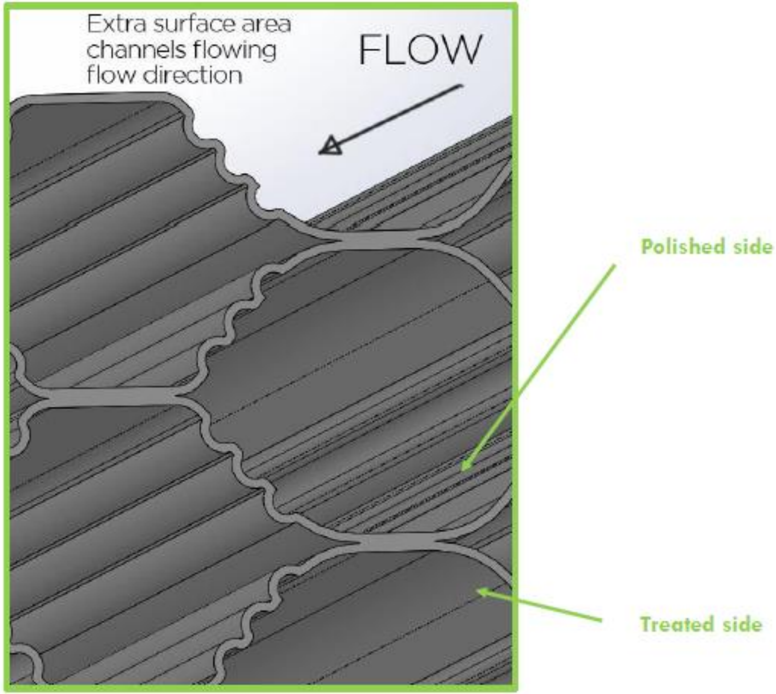


Wastewater is first treated aerobically in a primary treatment tank with enhanced fixed film material.

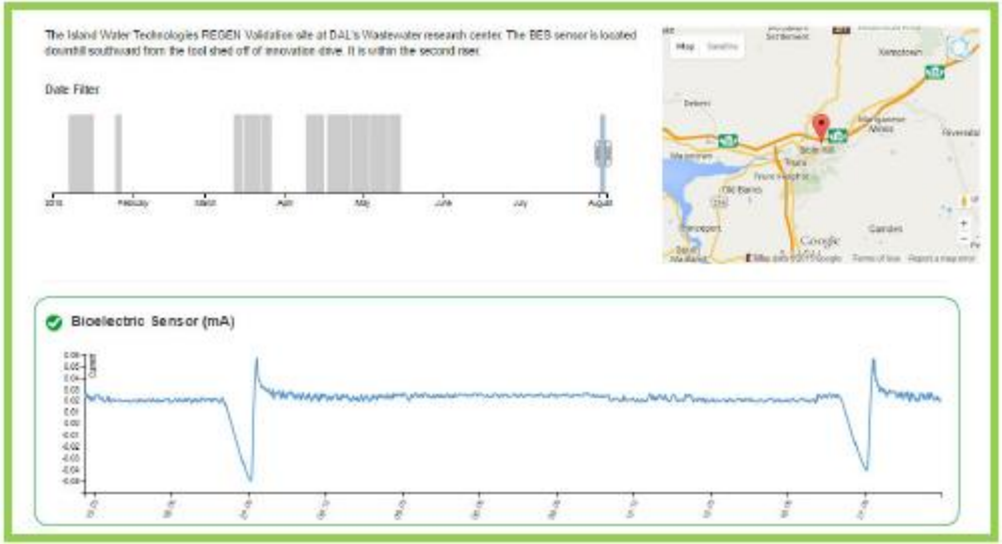
A secondary chamber provides additional filtration and disinfection based on specific customer requirements.

5: REGEN Technology development

Enhanced Wastewater Treatment



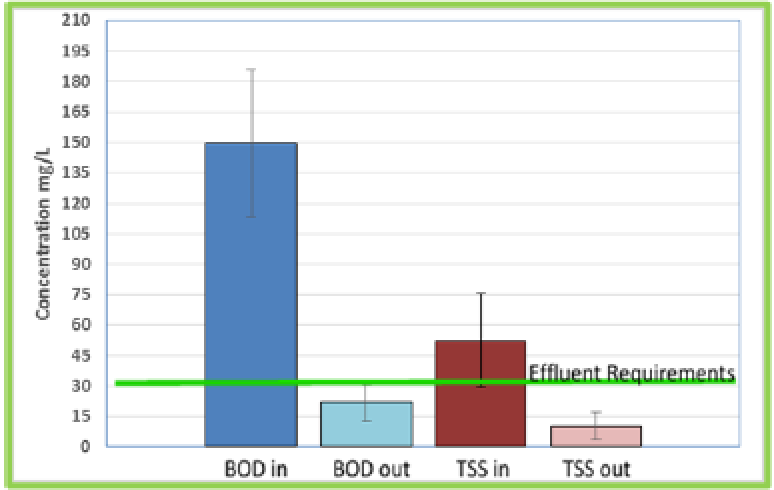
Bio-electrochemical Monitoring Remote Monitoring and Control



REGEN Demonstration and Commercial Applications

5: REGEN Technology development

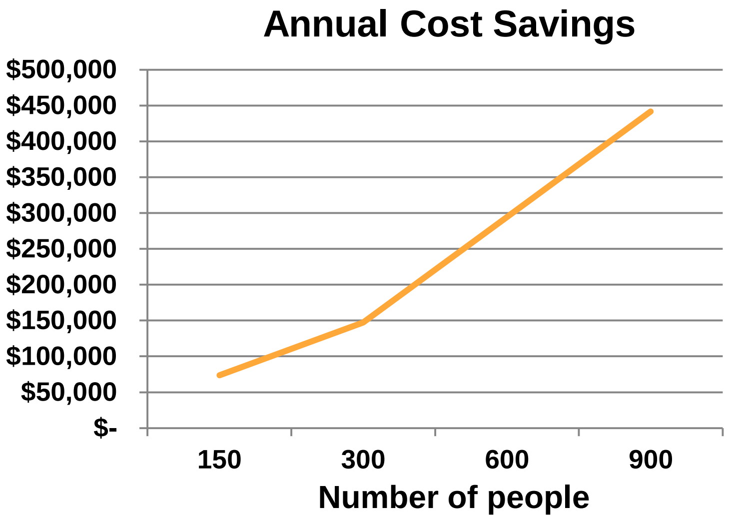
REGEN Demonstration System		
Parameter	**Value**	**Unit**
Flow	1500-1800	GPD
PE	20-25	people
HRT	1.1-1.3	days
Aeration Energy	0.4-0.5	kWh/m3
BOD removal	85	%
TSS removal	80	%
Solar Panel Maximum Capacity	2.64	kW



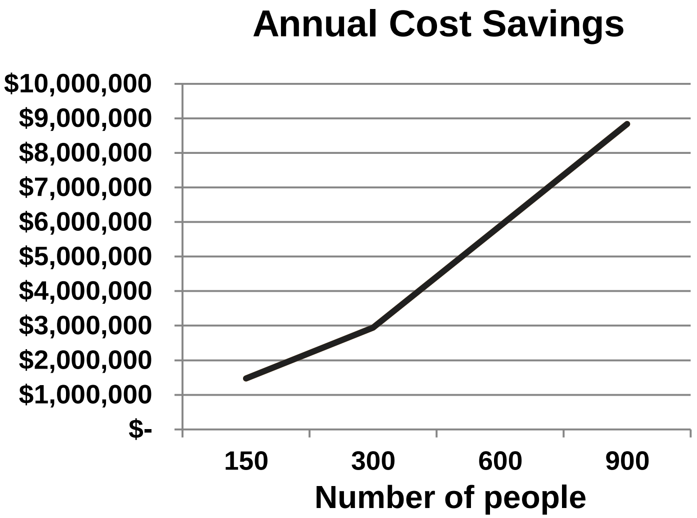
Typical Effluent Standard = 30 mg/L BOD / TSS

5: Solar commercial applications

Case Study: Remote Work Camp Community
Comparative Technology: MBR
150 persons
5 kWh / m3 WW
Fully Burdened Cost: $10 / gal gasoline



Case Study: Military / Humanitarian Mission
Comparative Technology: MBR
150 persons
5 kWh / m3 WW
Fully Burdened Cost $200 / gal gasoline



5: Solar Commercial Applications

BCIP REGEN Video:
https://www.youtube.com/watch?v=1C-jGqb-6NQ

Other milestones in commercial solar powered wastewater treatment worldwide

- City of Auburn, WA, U.S. (2013) = Centralized WW plant = 100% solar powered, 680 kW PV
- Sydney, Australia = Centralized, floating solar

- Ventura County, California, US = 1.1 MW solar plant, 75% of electrical requirements
- City of Homer, Alaska = Solar powered aeration of lagoons

Announcement

Major Luc Doré (Directorate of Land Requirements 7-4, Canadian Army)

` `I feel privileged to be able to support Canadian businesses; the Build in Canada Innovation Program offers us the opportunity to test cutting-edge innovations that could potentially be beneficial to our future operations.

Particularly, technologies such as the REGEN system from Island Water Technologies offers us the opportunity to bring economical and tactical benefits by reducing energy consumption, waste, and the environmental footprint of our military compounds in operations. One of the main advantages is the potential to reduce the number of soldiers in harms way who would have been otherwise required to provide logistical support. ` `

5: REGEN Commercial Applications

Product Description	ClearPod™	REGEN™ 20	REGEN™ 40	REGEN™ 20 plus+	REGEN™ 40 plus+
	Drop-in solution for enhanced on-site performance	Containerized, low-energy, packaged wastewater treatment plant.	Containerized, low-energy, packaged wastewater treatment plant.	Containerized, low-energy, packaged wastewater treatment plant.	Containerized, low-energy, packaged wastewater treatment plant.
Dimensions	18" x 18" x 34"	20' x 8' x 8'	40' x 8' x 8'	20' x 8' x 8'	40' x 8' x 8'
Flow Capacity (L/day)	1,250 (per unit)	12,500	25,000	37,500	75,000
Person Equivalent (PE)	4-6	50	100	150	300
Aeration Energy Usage (kWh/m3 wastewater)	0.5	0.5	0.5	0.5	0.5
Routine Operation and Manitenance Requirements	Annual 2-hr check up	Monthly 2-hr check up	Monthly 2-hr check up	Bi-weekly	Bi-weekly
Standard Effluent (BOD/TSS)	25/25	15/15	15/15	15/15	15/15

6: Summary

Distributed management approach to wastewater treatment, that incorporates decentralized solutions, results in reduced risk and significant economic and environmental benefits. Technology limitations have hindered adoption.

Self-powered, decentralized wastewater treatment solutions have the potential to drastically reduce energy utilization and costs (> 80%) associated with traditional centralized wastewater treatment.

Technology developments for decentralized solutions now enable cost-effective distributed wastewater treatment .

Solar powered operation allows for a more robust infrastructure, improved system performance, reduced GHG emissions and can result in reduced life-cycle costs.

Thank you

CTCN
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Environment, Community and Local Government

Governments of Switzerland and Germany

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Thank you

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IslandWater TECHNOLOGIES

3: Contaminants of Emerging Concern

Can we identify enabling solutions for the decentralized space?

Comparative analysis of effluent water quality from a municipal treatment plant and two on-site wastewater treatment systems

CrossMark

Santos N. Garcia [a,b], Rebekah L. Clubbs [a,c], Jacob K. Stanley [a,b,c], Brian Scheffe [a,c,d], Joe C. Yelderman Jr. [c,d,e], Bryan W. Brooks [a,c,d,*]

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[e] Department of Geology, Baylor University, One Bear Place #97266, Waco, TX 76798, USA

- Standard septic compared to aerated septic and municipal treatment
- Study tested after the treatment units, not the soil adsorption system
- Positive impact of aeration on reducing concentrations of endocrine disrupting compounds (EDCs)
- Similar results for Daphnia magna (freshwater flea) mortality