From Advanced Septic System Challenge to Sensor Challenge

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2012/13 Advanced Septic System Challenge

- Design a decentralized onsite wastewater treatment system that:
  1. Reduces nitrogen discharge to 95th percentile / <5mg/L
  2. Costs $5,000-$15,000 for a retrofit or <$30,000 new
  3. Incorporates remote or on-site sensing technology to monitor performance
  4. Starts up rapidly and operates successfully under conditions of seasonal or intermittent use
  5. Can be implemented on a broad scale
     - Secondary criteria: Reduces phosphorous discharge and recovers energy

Advanced Septic System Challenge Timeline

2012	• **DECEMBER** Launched septic system challenge with CCC, MA DEP, & R1
2013	• **JUNE** Revised the challenge & response poor • **JULY** Attended State Onsite Regulatory Alliance (SORA) meeting & began work with OWM
2012-2014	• Met with technology innovators: Gates Foundation, CalTech, Kohler Co, Cambrian Innovation, current innovative/alternative onsite wastewater treatment system (I/A OWTS) manufacturers & DOD ESTCP about wastewater research

Lessons Learned from the 2012/13 Challenge

Manufacturers aren't going to invest the money in innovation unless:

- State permitting process streamlined
- Communities issue mandates for upgrades

For each state to evaluate advanced OWTS, it's a burden on state resources and staffing

A specific market opportunity is needed to attract technology development

State-by-state OWTS permitting is expensive, 50 states >$10M & 10 years

An OWTS is expensive because manufacturers need to recoup their costs

Regulators want long-term assurance & don't trust manufacturers

From Advanced Septic System Challenge to Sensor Challenge

2013-2015	• Worked with OWM on the successful 5 state Chesapeake data sharing agreement
2014	• Introduced OWM to NIST's Standards Coordination Office & proposed OWTS national data sharing agreement to streamline permitting • Organized 2 meetings with SORA, NIST, & OWM • **JUNE** Began working with Suffolk County & Region 2
2015-2016	• Worked with the 6 NE states, NY & Suffolk County regulators, Regions 1 & 2 on a regional data sharing agreement, but not signed

Industry Perspectives

"One of Kohler's concerns in developing new decentralized wastewater treatment technologies and systems is the lack of harmonized performance requirements between the states. Currently, each state has its own protocols for testing treatment effectiveness … But a manufacturer like Kohler (and indeed anyone who's looking to innovate in this space) would benefit from the certainty and scale of a national program."

KOHLER®

Rob Zimmerman
Senior Manager, Sustainability
Kohler Co.
Kohler, Wisconsin

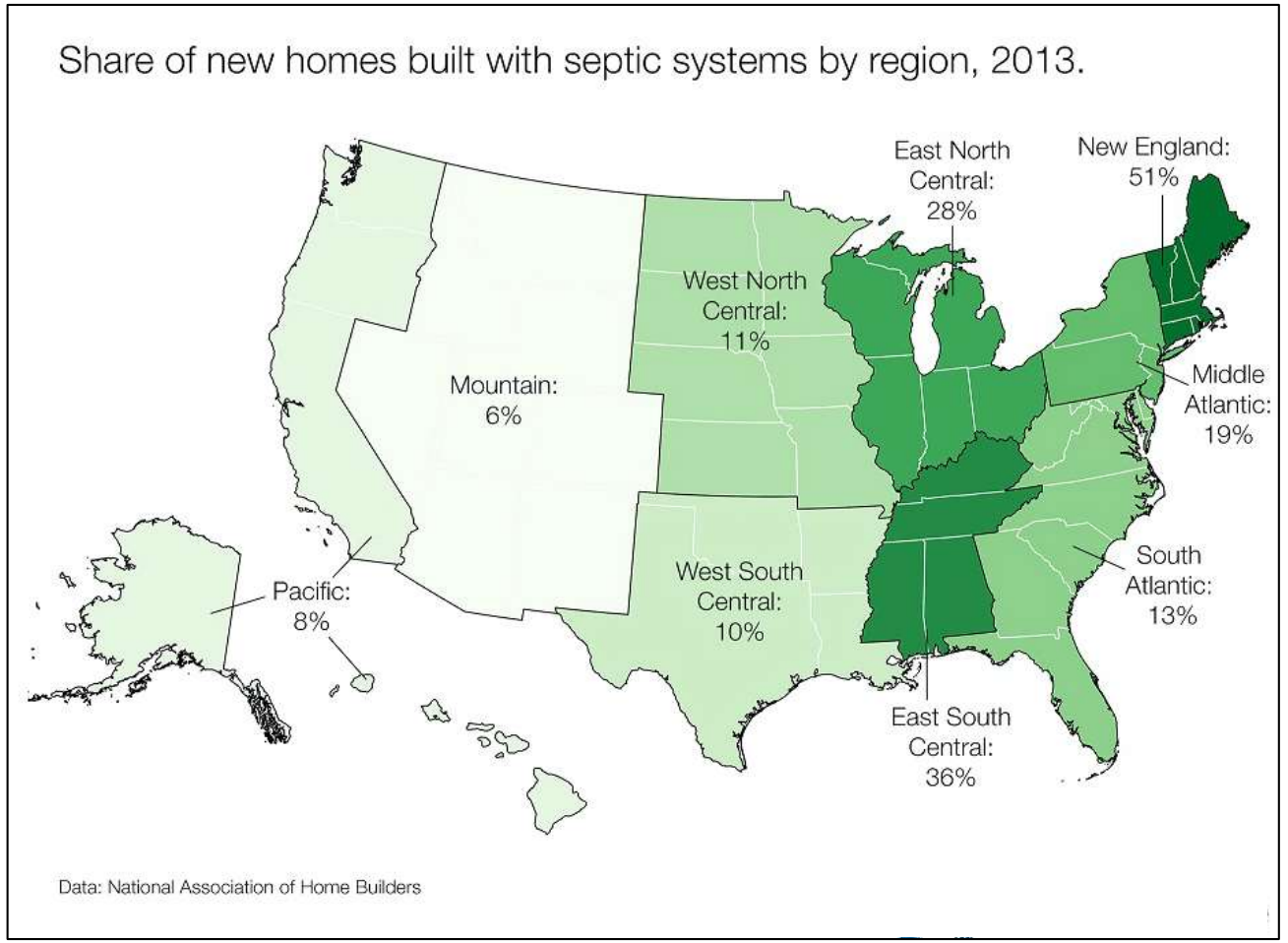
Developing the Sensor Challenge in 2016

- Suffolk County Long Island agreed to be the initial market
  - 360,000 conventional septic systems and cesspools
  - >200,000 of these systems are in nitrogen sensitive areas & need replacement
  - DHS (Walter Dawydaik) would like sensors on all new I/A OWTS
- Sensor Challenge performance goals developed by MASSTC, URI, 6 NE & NY, NJ state regulators, Suffolk County, TNC, EPA R1 & R2, ORD, OWM
- Current cost of monitoring in MA for permitting
  - $300 to sample 1 OWTS & run lab tests
  - $4,500 to monitor one OWTS for 4.5 years, for the 50 systems= $155,250
- Sensor Challenge Phase I Prizes
  - EPA OWM gave $50,000
  - EPA ORD provided the InnoCentive funding & $5,000

National Market Potential

Sensor market = cesspools/septic systems that threaten drinking water or coastal ecosystems & will soon require N removal technology

- **Current estimate**: more than 10% of all septic systems nationally (**Over 2.6 million systems**) & climbing
- New England & Chesapeake markets are estimated at 500,000+ systems up for replacement in the next 10 years



Proposed Sensor Design Specifications

Attribute	Attribute Description	Performance Goals		
		Minimum	Almost Ideal	Ideal
Parameter	What is being measured	NO_3^-, NH_4^+	NO_3^-, NH_4^+, TOC	Total nitrogen (TN)
Installation Price	Price to the homeowner to install	$1,500	$1,250	$1,000
Data Management	Ability to record and transmit data (i.e., telemetry) for real-time access by practitioners, regulators, and interested stakeholders	Record and automatically transmit data to designated server or cloud	Record and automatically transmit data to designated server or cloud	Record and automatically transmit data to designated server or cloud
Applicability & Accessibility	Applicability of sensor(s) to various innovative/alternative system designs and ease of access to OWTS for installation and maintenance	Located in-situ to provide performance information on the OWTS; must be accessible for maintenance	Located in-situ to provide performance information on the OWTS; must be accessible for maintenance	Located in-situ to provide performance information on the OWTS; must be accessible for maintenance
Frequency of Sensor System Maintenance	How often the sensor(s) need to be maintained	No more than quarterly	No more than semi-annually	No more than annually
Accuracy	Accuracy of sensor measurements to the true measurement	Within 20% of true value	Within 20% of true value	Within 20% of true value
Precision	Repeatability of sensor measurements	≤30% RSD	≤20-30% RSD	≤20% RSD
Range	Range of the detection	2-60 mg N/L	2-60 mg N/L 2-60 mg/L TOC	2-60 mg N/L
Sensor Operating Temperature Range	Temperature range in which the sensor can operate	4° C to 35° C	4° C to 35° C	4° C to 35° C
Deployment	Period of deployment	Continuous	Continuous	Continuous
System Lifetime	Expected life of sensor	5 years	5 to 10 years	10 years

Benefits of Sensor Development

State & County Regulators

- Assurance of long-term system functionality (improved evidence to recommend them)
- Lower cost of data collection (currently $300 for collection & lab testing of 1 effluent sample)
- Minimization of human errors & time delays
- Improved standardization of methods & limits of detection

Industry

- New opportunity for innovation based on scientific breakthroughs
- Brand new market segment for the sensor, sensor maintenance, and data collection/analysis
- Important I/A OWTS verification device, which could streamline the permitting process & thereby reduce field testing costs for manufacturers

Homeowners

- Allows development of property in sensitive areas
- Assurance that I/A OWTS investment performs as advertised
- Facilitates routine maintenance to protect system longevity

Advanced Septic System Nitrogen Sensor Challenge Phase I, 2017

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- Submission period: 1/17/17 – 3/17/17
- Challenge partners: USGS & The Nature Conservancy
- EPA contracted with InnoCentive® to host the challenge online
- Ideation Challenge
  - Submitters encouraged to propose creative solutions toward meeting sensor design goals
  - Written proposals only, no prototypes
- Expert panel selected winners
  - 1st place: $20,000 – Dr. Baikun Li & Dr. Yu Lei, UConn
  - 2nd place: $15,000 – Jason Khoo, Stanford University
  - 3rd place: $10,000 – William Powers, PixController, Inc.
  - 4 honorable mentions: $2,500 each
- Winners were announced at Sensor Showcase Day on 6/29/17

Challenge Details – Phase II, 2018-20

- Phase II: Prototype Testing – open to any innovator
  - Teams submit working sensor prototypes
  - Sensors undergo up to 2 one month no risk tests
  - Sensors must pass a 1 week screening test embedded in the 1 month test for entry into verification testing
  - Selected sensors undergo the 6 month field verification test
  - Prize: **ISO ETV 14034 verification reports** for sensors which complete the 6 month test & meet minimum goals
  - Funding provided by ORD & OW/OWM
- Who will do the testing?
  - MASSTC according to an **ISO ETV Test Quality Assurance Plan** (T/QAP) developed by Battelle, EPA, Technical Panel, & VerifiGlobal: http://www.verifiglobal.com/en/

Phase II, 2018-20 Testing Schedule

- Workshop/webinar: 7/12/2018
- 1st no risk one month test: 10/24-11/20/2018
- 2nd no risk one month test: 2/27-3/28/2019
- By invitation only, 6 month field verification test:

  August 2019 – February 2020*
- Awards: **ISO ETV 14034 verification reports**, 5/2020**
- Proposed TNC order for 200 sensors: Summer 2020

http://www.verifiglobal.com/en/

*Date dependent upon at least one sensor passing the preliminary test
**Date dependent upon one sensor passing the 6 month ISO ETV verification test

2018-19 Testing Experience

- March 28 – April 3, 2018,1 week test
  - Tested UConn sensor & it needs further development
- October 24 – November 20, 2018
  - Tested T.E. Laboratories' nitrate and nitrite sensors, which passed the one week test
- February 27 – March 28, 2019
  - Tested nitrate, nitrite and ammonium sensors from:
    - T.E. Laboratories Ltd.
    - s::can Measuring Systems, LLC
    - SUNY Stony Brook, Professor Zhu

Who Influenced the Course of the Challenge?

How Could You Help?

After we have a sensor, we will still have this underlying problem:

The lengthy and expensive state by state I/A OWTS approval process is a barrier to innovation and the development of a cost effective I/A OWTS, which can tackle nutrient pollution.

Could the states collaborate on I/A evaluations and share piloting data in order to streamline the costly state by state approval process?

How? By working with ECOS and SORA or through an interstate data sharing agreement.

Thank you!

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