

## DOCKETED

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**IrriGreen Comments on 17-AAER-18 on Irrigation Spray Head Technologu**

*Additional submitted attachment is included below.*

# Comments on Docket #17-AAER-08, Sprinkler Spray Bodies

## Questions Addressed

Identify manufacturers of spray sprinkler bodies: [IrriGreen, Inc.](#)

Identify new products that have been introduced to the market recently... products and technologies not addressed in #17-AAER-08: Digitally Controlled Spray Heads with Embedded Software

Identify new products that provide increased water savings: [The IrriGreen Genius® Irrigation System](#)

## Where is the Water Going?

Irrigation is the largest use of residential water in the United States — more than all others combined (Figure 1). Reducing irrigation water use is imperative for making communities more sustainable.

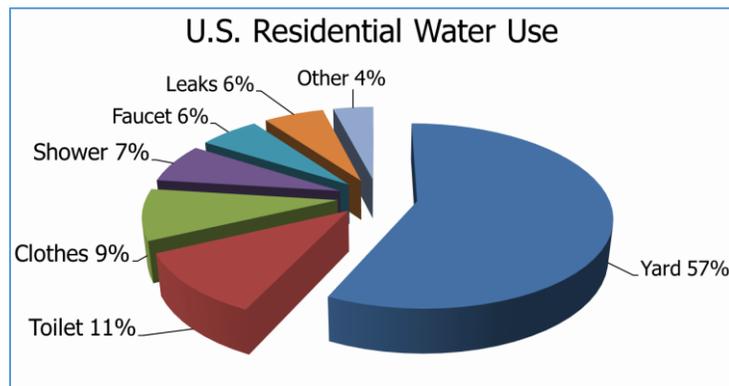


Figure 1.

## Acres of Turf

Americans love our lawns, and with good reason: they filter stormwater, help clean the air, absorb carbon dioxide, provide children a place to play and adults a place to relax. In fact, the U.S. has more than 40 million acres of grass (Figure 2). Regardless of the size of a lawn, turf grass requires water — a lot of it.



Figure 2.

## 4-5 Billion Gallons Lost Daily

According to the U.S. Environmental Protection Agency (EPA), as much as 50 percent of the water used outdoors for lawn irrigation is wasted due to inefficient and ineffective watering methods and systems. Everyone has seen irrigation systems spraying water when it is not needed (during a rainstorm) and where it is not needed (on the sidewalk). The problem is not just inaccuracy and inadequate system control. **By design, most lawn irrigation systems and sprinkler heads must waste water in order to cover entire lawn areas adequately.**

## Limitations of Mechanical Sprinkler Heads

### Waste from Spray Overlap

Current turf irrigation technology uses mechanical sprinkler heads, which water in an arc and are placed one head distance from each other in order to intentionally overlap their sprays (Figure 3). This is the only way they achieve adequate watering.

Distribution Uniformity (DU) is a measure of how evenly water is applied across an area during irrigation. For instance, if one inch of water is applied in one part of the lawn and only half an inch in another, distribution is not uniform. DU is expressed as a percentage between 0 and 100 percent (perfect). In Figure 3, a DU of .65 is shown for a watering zone with six mechanical sprinkler heads. Actual DU of field-tested systems ranges from .39 to .76 in various studies, averaging about .55.

**As illustrated, with a DU of .65, because conventional, mechanical sprinklers must overlap sprays, three-fourths of the total lawn area is over-watered by 60 to 95 percent in order for all sections to receive enough water.** This inefficiency is an inherent, intractable limitation of current mechanical sprinkler technology.

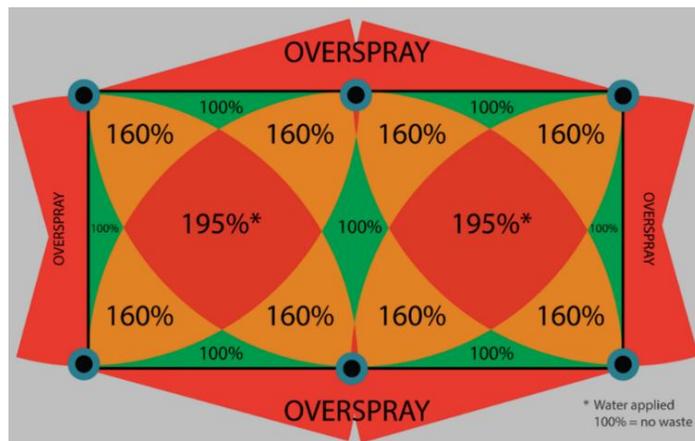


Figure 3.

The .65 Distribution Uniformity (DU) illustrated here is the accepted national standard according to the EPA. **Thus, even when they meet WaterSense standards, mechanical sprinkler heads over-water and waste water – in total, as much as half of the water applied.**

### Waste from Overspray and Run-off

In addition to the intrinsic limitations on watering efficiency due to the necessity of overlapping sprays, today's mechanical sprinklers waste even more water due to over-spray and

runoff. Difficult to adjust and control while in operation, spray heads and rotors over-spray onto adjacent hardscapes (patios, driveways, streets, etc.). Because sprinkler heads are positioned on the perimeter of irrigation zones, they are also susceptible to water loss due to run-off and wind drift. According to the Alliance for Water Efficiency, 15 percent of the water applied by mechanical systems is lost due to over-spraying and run-off. ***In sum, with inefficient overlapping sprays, plus over-shooting onto hardscapes and run-off from the edges of irrigation zones, mechanical systems waste as much as 50 percent of the water used for lawn irrigation.***

## Limitations of Irrigation Technology Innovation

New technology has enabled progress in irrigation controllers, replacing irrigation clocks that are only time-based. Internet-connected irrigation controllers intelligently turn off sprinkler systems to save water. These new controllers make seasonal adjustments, use weather data and moisture sensors, and many of them communicate with Smartphones, turning off sprinklers when they are not needed.

Moisture sensor innovation has advanced from wired sensors to wireless sensors. It has also moved from simple rain detectors to more advanced moisture sensors and weather stations. These new sensor technologies enable more fine-tuning of each watering cycle, which optimizes grass health and watering efficiency.

***Controller and sensor innovations improve irrigation efficiency by determining when sprinkler systems turn on and off. However, once the system turns on, current mechanical sprinklers still waste water with overlapping sprays, over-spraying, run-off and wind drift. In the industry, this conundrum is called “smart control, dumb sprinkler.”***

## Digitally Controlled Sprinkler Heads with Embedded Software

The key to dramatic increases irrigation system efficiency and water savings is to extend digital control from the controller out to the sprinkler heads. That is, design smart sprinkler heads that are themselves computerized. The challenge is to transform irrigation systems from mechanical equipment controlled by digital technology into end-to-end computerized, smart systems.

The IrriGreen Genius® System (Figure 4) represents this next evolutionary step in irrigation technology innovation. The IrriGreen Genius Irrigation System includes the programmable Genius Sprinkler Head, the Genius Wi-Fi Controller and Server, and the Genius Mobile App.



The Wi-Fi Controller and Server uses an algorithm to regulate the rotational speed of the Sprinkler Head, the volume and pressure of water (40-80 PSI) delivered through the head's 14 nozzles, and the direction and distance

of the water sprays (up to 35 feet).



Controlling these variables, based on the mapping points set by the installer via the Mobile App, [the IrriGreen Genius Irrigation System regulates its water sprays to match the shape of the lawn](#) and waters uniformly without overlapping sprays or over-spraying past areas of lawn.



Figure 4.

The company took a novel approach, covering a large area like current mechanical spray heads using multivolume streams, but the streams get bigger the farther they are from the head. The patented nozzle design provides sufficient streams to cover the lawn uniformly from five to 35 feet from the Genius Sprinkler. Each stream has a different trajectory, and unlike sprays from mechanical heads, it adjusts the distance as it rotates and thereby conforms watering patterns to the shape of the lawn.

A patented computer algorithm continuously adjusts the stream distance and application rate. The system is designed to apply a uniform 0.05 inches of water with each revolution, thus allowing the system to water in inches rather than in minutes. The software and Mobile App remove all the design work needed with mechanical technology to match precipitation within a zone, and from zone to zone.

Current mechanical sprinkler technology has particular difficulty watering irregularly shaped areas. Overlapping head-to-head, mechanical sprinklers, as noted, are designed to water squares and rectangles. They do not have the adaptability to negotiate curves and corners or to water around obstructions. This is why mechanical sprinklers overshoot and waste water spraying onto hardscapes. Thus, not only do they lose efficiency from overlap, but also from the failure to conform to the shape of the landscape. Without the need to be placed head-to-head, a computer-controlled sprinkler placed in the center of each irrigation zone can be adjusted to avoid hardscapes and decrease runoff.

Like an inkjet printer spraying ink in precise patterns on a page, IrriGreen Genius Sprinklers “print” water in computer controlled patterns that conform to the specific outline of any lawn. Instead of rows of four to eight mechanical sprinkler heads positioned around the outside edge of each irrigation zone and watering from the outside-in with inefficient overlapping sprays that waste water, IrriGreen waters from the inside-out with just one head in the middle of each zone and no spray overlap. IrriGreen’s smart sprinklers adjust the direction and distance of sprays as the heads rotate (up to 437 times per rotation). The radius of their multi-volume

water streams follows the digital map of each zone installers set with the Genius Mobile App on their Smartphones.

## Water Savings

Computerized sprinklers can provide significant water savings, with an opportunity to reduce water use up to 50 percent compared to mechanical heads.

***In 2016, system testing by the [Center for Irrigation Technology \(CIT\)](#) demonstrated that IrriGreen achieves watering results (increases in measured soil moisture) comparable to standard irrigation systems while using 40 percent fewer gallons of water.***

CIT tested IrriGreen with one Genius computerized smart head per irrigation zone against conventional systems with six to nine mechanical rotors or spray heads per zone. It is important to note that the CIT test plot was a perfect square, the easiest shape for mechanical systems to water. Installed by experts in irrigation technology, the configurations of mechanical heads were calibrated with a Distribution Uniformity (DU) of .65 to meet WaterSense standards. Thus, conditions were ideal for the traditional heads. As noted, the DU of field-tested systems is much lower, ranging from .39 to .76 in different studies and averaging about .55. Therefore, the CIT tests may understate IrriGreen water savings.

(There is also considerable labor savings during installation due to the fewer number of heads used. With only one head per zone instead of 4-8, IrriGreen installs with as much as 70 percent less pipe. There are no lateral lines to trench, and fewer holes to dig. Labor hours can be reduced by 50 - 70 percent for comparably sized installations.)

## Conclusion

Computerized, smart sprinkler heads are making headway as an alternative to current mechanical heads used for irrigation. They do not overlap sprays. They do not over-spray but rather match watering patterns to the shape of the lawn. Installed in the middle of irrigation zones rather than along the outside edges, they do not lose water to run-off.

Digitally controlled spray heads with embedded software represent an innovative, water-saving technology that the State of California should carefully consider in setting standards for lawn irrigation. There is no doubt that the advantages of computerized heads, like many other computer-based products, will drive adoption. ***Installed with today's innovations in controller and sensor technology, irrigation systems with computerized spray heads save water by turning on and off at the right times (regulating the "when") and then maximize water savings when the system is operating (digitally directing the "where").***

## Additional Background Information

IrriGreen, Inc. is a technology and manufacturing company headquartered in Edina, Minnesota. IrriGreen designs, develops, and manufactures irrigation products for watering residential and commercial lawns and landscapes. The IrriGreen Genius® Irrigation System uses patented nozzle design and digital technology, adapted from the engineering of high-tech printers.<sup>1-6</sup> The company began commercial sales of its system in 2014.

## History

Gary Klinefelter is the founder and Chief Executive Officer of IrriGreen. Before starting IrriGreen, Klinefelter was Vice President, Technology at Fargo Electronics. He was responsible for filing more than 35 U.S. patents and guided the introduction of more than 20 high-tech, commercial inkjet printing products.

Klinefelter wanted to purchase and install a lawn sprinkler system at his home. When he watched mechanical sprinkler systems in operation, he observed inefficiency and water waste (run-off from sprinklers located at the edges of lawns and over-spraying past lawn areas onto adjacent hardscape surfaces). Printers spray ink in precise patterns on a sheet. Thus, Klinefelter wondered if sprinklers could be designed to “print” water in similarly controlled patterns on lawns. That question was the inspiration for IrriGreen.<sup>7-8</sup>

IrriGreen filed a proof of concept patent in 2011 and completed prototype development in 2012. The company fielded the first 200 of its Genius Sprinkler Heads in 2013, and sold its first system in 2014. The following year, IrriGreen developed its Genius mobile app, which controls its system. Also in 2015, IrriGreen secured its first two patents.<sup>9-10</sup> The patents were granted in Australia. One patent (#2013200998) covers the design and function of the multi-volume spray nozzle in the IrriGreen Genius Sprinkler. The second patent (#201324391) is for IrriGreen’s software algorithm, which controls the direction, stream distance and rotational speed of its sprinkler heads.

In 2016, system testing by the [Center for Irrigation Technology \(CIT\)](#) demonstrated that IrriGreen achieves watering results (increases in measured soil moisture) comparable to standard irrigation systems while using 40 percent fewer gallons of water.<sup>11-13</sup> By 2017, the company had established distribution in 20 states, plus Canada and Mexico, through 12 distributors with 114 warehouse locations. In May 2017, the company was awarded its first U.S. Patent (9643196).<sup>14-16</sup>

## Recognition and Awards

[Finalist, Irrigation Show New Product Awards](#)

[Twenty for 2016 Best New Products](#)

[Water Savings - 2015 Money-Saving Products](#)

Eureka! Award<sup>17-18</sup>

[Finalist, Tekne Awards](#)<sup>19</sup>

Semi-finalist and Finalist, Minnesota Cup<sup>20-21</sup>

[Architectural Products 2014 Product Innovation Award](#)<sup>22</sup>

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2. IrriGreen introduces new irrigation system, [Landscape Management](#) (September 10, 2014)
3. Where Water Efficiency Increases ROI, [ABInsight](#) (October 14, 2014)
4. IrriGreen Genius Irrigation System, [Landscape and Irrigation](#) (October 28, 2014)
5. Water Smarter, [Landscape Contractor Design-Build-Maintain](#) (November 2014)
6. IrriGreen taps digital technology to get traction in market, [Total Landscape Care](#) (July 23, 2015)
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9. IrriGreen granted two patents in Australia, [Lawn and Landscape](#) (December 16, 2015)
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13. Center for Irrigation Technology Grades IrriGreen System: Tests Prove Notable Efficiency, Water Use Reduction, [Landscapeonline](#) (November 7, 2016)
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17. Minnesota innovators win 2015 Eureka! awards, [Minneapolis St. Paul Business Journal](#) (May 15, 2015)
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20. IrriGreen selected as semifinalist, [Lawn and Landscape](#) (June 17, 2015)
21. 2015 MN Cup Finalists Announced, [Twin Cities Business](#) (August 18, 2015)
22. IrriGreen Genius Irrigation System Wins Product Award, [Green Lodging News](#) (November 18, 2014)



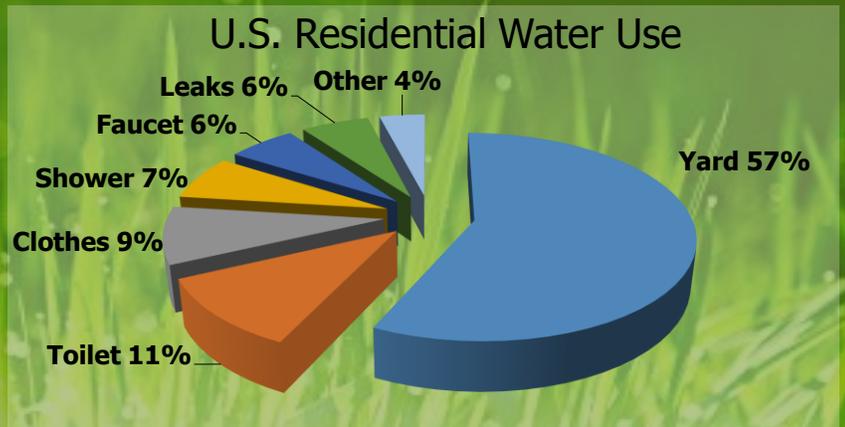
# IrriGreen

A New Category of Irrigation Technology:  
Digitally Controlled Sprinklers with Embedded Software

6/12/2017

## Irrigation Waste: Billions of Gallons

Outdoor water use is the biggest use of residential water use in the U.S. According to the EPA, 4 to 5 billion gallons of water are wasted **daily** because of inefficient and outdated sprinkler technology (EPA)



## Why Mechanical Systems Overlap...

**Current systems, by design, overwater some sections... Otherwise, other sections get too little**



**Head to head coverage is required for all mechanical heads... including "MP Rotor" types**

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## Over-spray and Run-off Waste Additional Water

15% water applied per watering event is lost to overspray and runoff  
(Alliance for Water Efficiency)

Mechanical sprinklers are on lawn perimeters, causing over-spray and runoff on sidewalks, streets, etc.



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## Conventional Irrigation System



40 heads

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## IrriGreen Genius System



5 heads

5

VS

## IrriGreen is CIT Validated

- Good Operational Efficiency
- One IrriGreen head versus 6-9 traditional heads
- Equivalent soil moisture using 40% fewer gallons of water



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# The IrriGreen Genius® is a Complete System

From the mobile app controller, to the wireless network, to the smart sprinkler head, the entire system is what makes the product Genius®.



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## Summary



Stop the irrigation water waste, 4 billion gallons a day.



IrriGreen's patented sprinkler system uses inkjet technology to "print" water in the shape of your yard using 40% less water. Digital control and efficiency.



Same installed cost as a properly designed conventional system.



Environmental awareness means people are interested in saving water. Let's help them to save where it really makes a difference ... in their lawn.

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