

# Investing in Innovation: Delivering course maintenance

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5th Golf Innovation Symposium

USGA®





## ECONOMIC

- Demand for higher productivity
- Rising cost of maintenance: labor, water, fuel, time, fertilizer, energy
- Socioeconomic and social justice issues

## ENVIRONMENTAL

- Water: quality and scarcity concerns
- Resource use efficiency
- Drive to reduce carbon (GHG) emissions
- Reduce chemical inputs
- Biodiversity conservation
- Regulatory compliance
- Natural capital & ecosystem services

## TECHNOLOGICAL

- Improved sensors & connectivity
- Big data platforms
- GIS capability
- Improved maintenance equipment

# Use Your Money Wisely

## Save water

- Saving water saves energy
- Utilize technology to make watering decisions: moisture sensors are more valuable than weather stations
- Consider what the weather is going to be not what it has been

## Stretch out equipment investments

- All equipment does not age at the same rate
- Consider reliability: where is it of the most value to you?

## Consider labor productivity in equipment decisions

- Ride v. walk greens
- Consider mowing patterns “north/south” v. cross cutting

## Invest money where it benefits playability

- Are you maintaining where golf is played?
- Are you spending labor to improve the playability or appearance

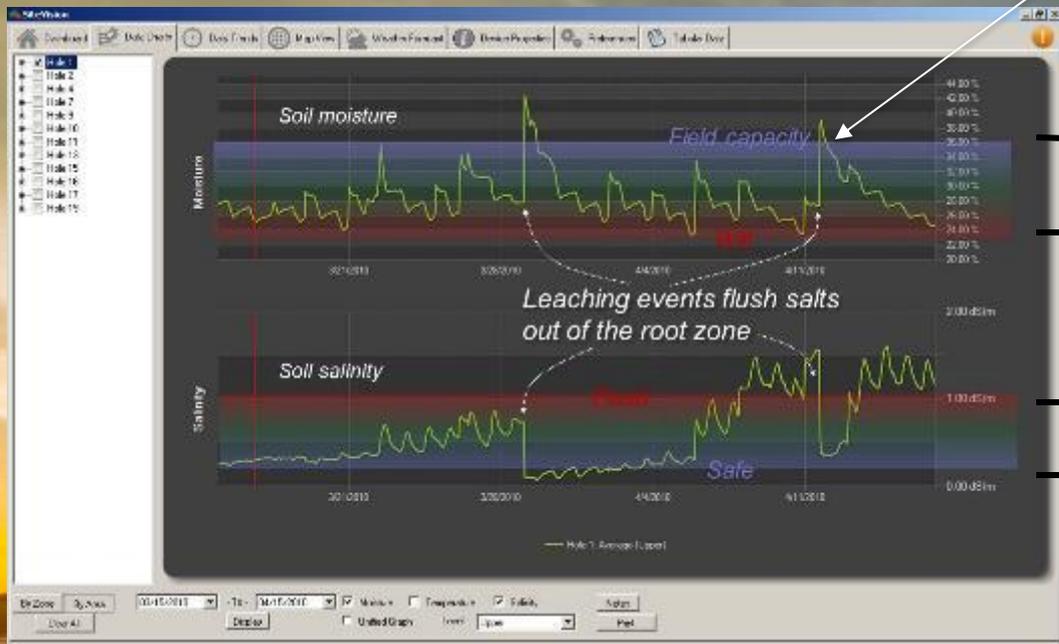
## Consider total cost of ownership

- Labor productivity
- Maintenance cost
- Cost of consumables



SENSORS ALLOW FACTORS THAT IMPACT TURF PERFORMANCE TO BE QUANTIFIED

# Data from Soil Sensors



Water applied in excess of “full point” is wasted through leaching beyond the root zone

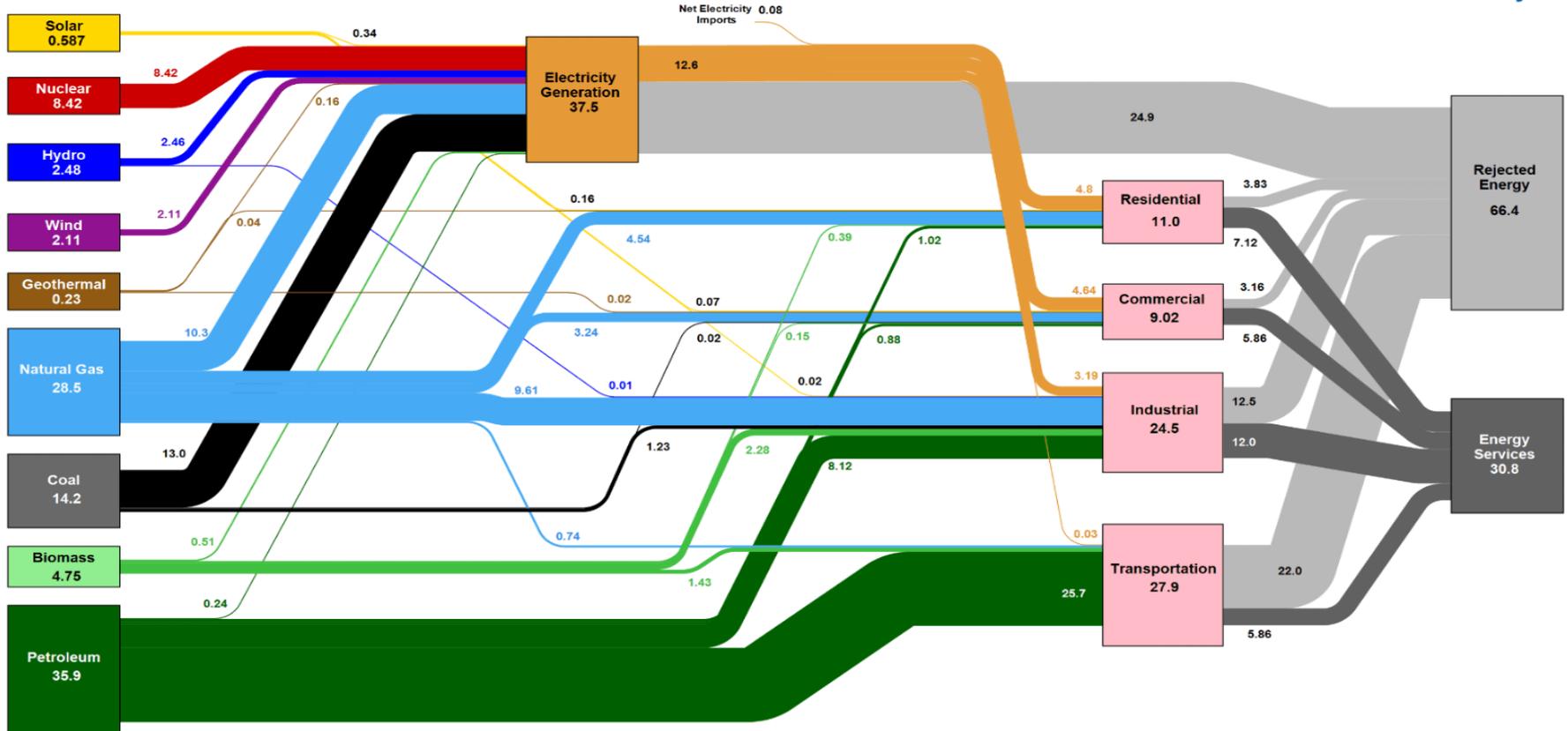


- Allow us to precisely measure soil moisture
- Is like the fuel gauge in a car, allows the application of water when required
- Can calibrate sensors to “empty” and “full”
- Sensors are the most precise method of measuring plant available moisture

# Why Electric Products?

Estimated U.S. Energy Consumption in 2016: 97.3 Quads

Lawrence Livermore  
National Laboratory



# Electric Products Benefits

- No possibility of hydraulic leaks
- Substantially higher efficiency
  - Reduced fuel consumption
  - Lower carbon footprint
- Smart product: less operator skill required
- Higher quality of cut: speeds what they need to be
- Fewer wear parts
- Easier diagnosis

# Many Types of Hybrids

Some  
Electrical  
Content

*If categorized by amount of electric content...*

Mostly  
Electrical  
Content

“Mild” hybrids

“Full Hybrids”



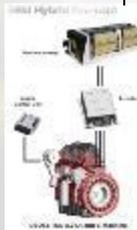
**Toro & Deere e-Reels (Hydraulic + Electric)**



**Toro RM5010-H (PowerMatch)**

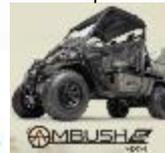


**Ford Stop-Start Hybrid**



**Jacobsen eClipse Series Hybrid**

**Deutz Construction (Hydraulic + Electric)**



**Military & Hunting Stealth Vehicles**



**Toyota Prius Parallel Hybrid (Mechanical + Electric)**

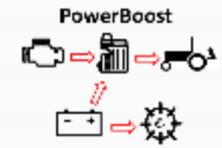
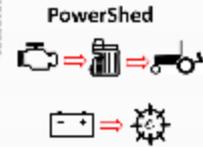
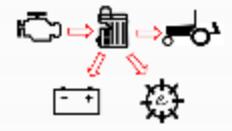


**Chevy Volt (PHEV)**

# Hybrid and Electric Products



**HYBRID:**  
While providing the same power 20 (24) hp or available, it has available or stored in a fuel tank. Fuel use varies, due to it's cutting until reaching battery and fuel power.



3 hp
24.8 hp
<b>Typical load</b>
Fluff grass, with the mulch decks
100%

3 hp
6 hp
24.8 hp
<b>Moderate load</b>
Intermediate hills and slopes
Up to 80%

3 hp
8 hp
6 hp
24.8 hp
<b>Extreme load</b>
Severe and rounded inclines
Up to 100%

# Precision Management

The precise application of inputs based on site needs:  
Applying inputs only where they're needed, in the right amounts  
and at the right time to produce a functional landscape.

## Efficiency requires Precision requires Information requires Sensors & GIS

- Water use
- Fertilizers
- Fuel
- Chemicals
- Labor
- Equipment
- Operating budgets

- Precise application & management of all resources

- Critical agronomic site conditions

- Soil properties
  - Moisture
  - Compaction
  - Fertility
  - Salinity
- Turf performance
- Topography/Relief
- Weather
- GPS

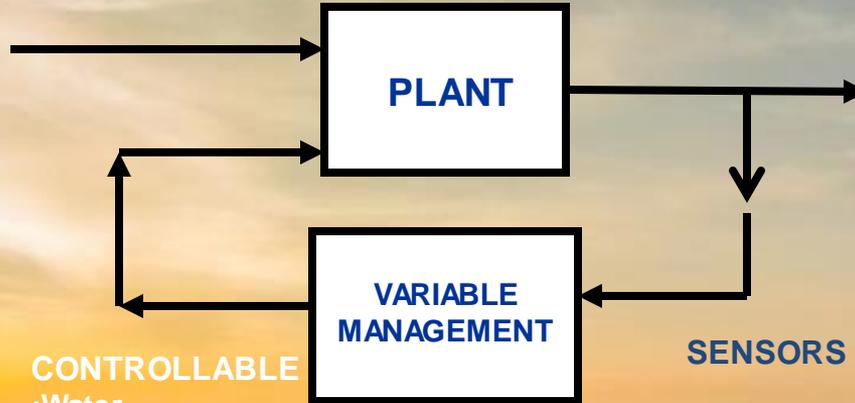
**THE OBJECTIVE** is to provide landscape managers with actionable information that empowers them to create a functional landscape while reducing labor, financial, and material inputs thereby increasing profitability and reducing environmental impact.

# Precision Turf Management

Applying the right amount, in the right place, at the right time

## UNCONTROLLABLE

- Weather
- Soil Type
- Diseases/pests



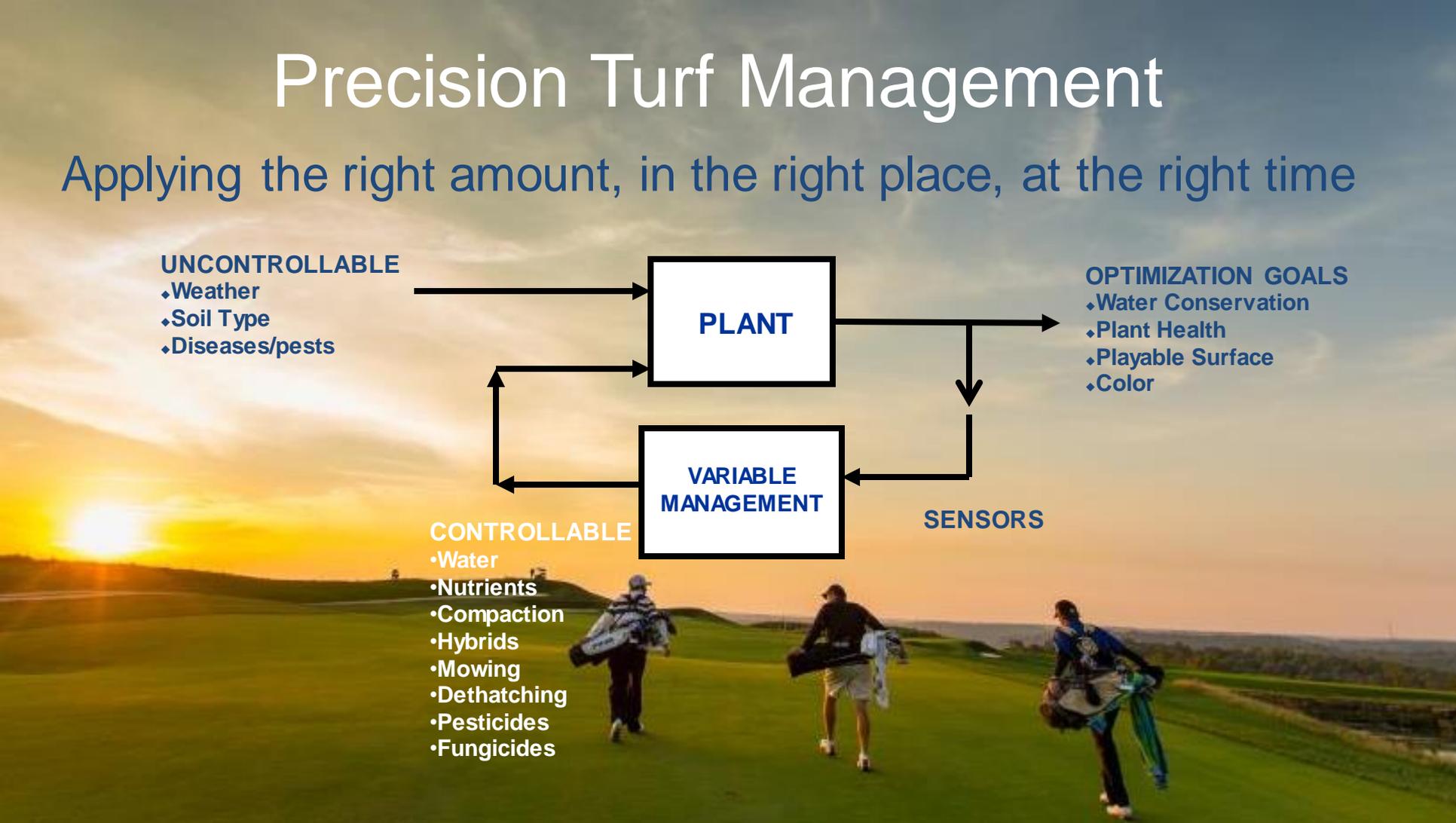
## OPTIMIZATION GOALS

- Water Conservation
- Plant Health
- Playable Surface
- Color

## CONTROLLABLE

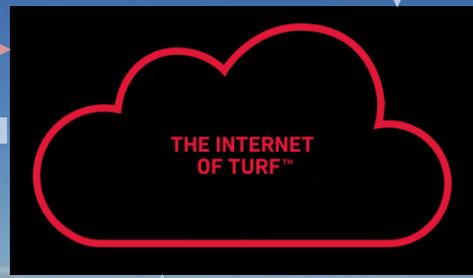
- Water
- Nutrients
- Compaction
- Hybrids
- Mowing
- Dethatching
- Pesticides
- Fungicides

SENSORS



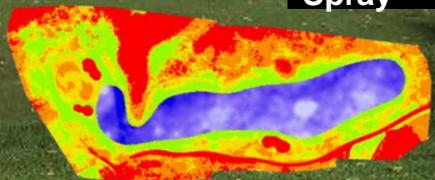
By incorporating GPS, GIS, and Maps into management technology, greater value can be generated and practices can be optimized and **AUTOMATED**

Current conditions & forecast



- Automation
- Optimization
- Control
- Monitoring

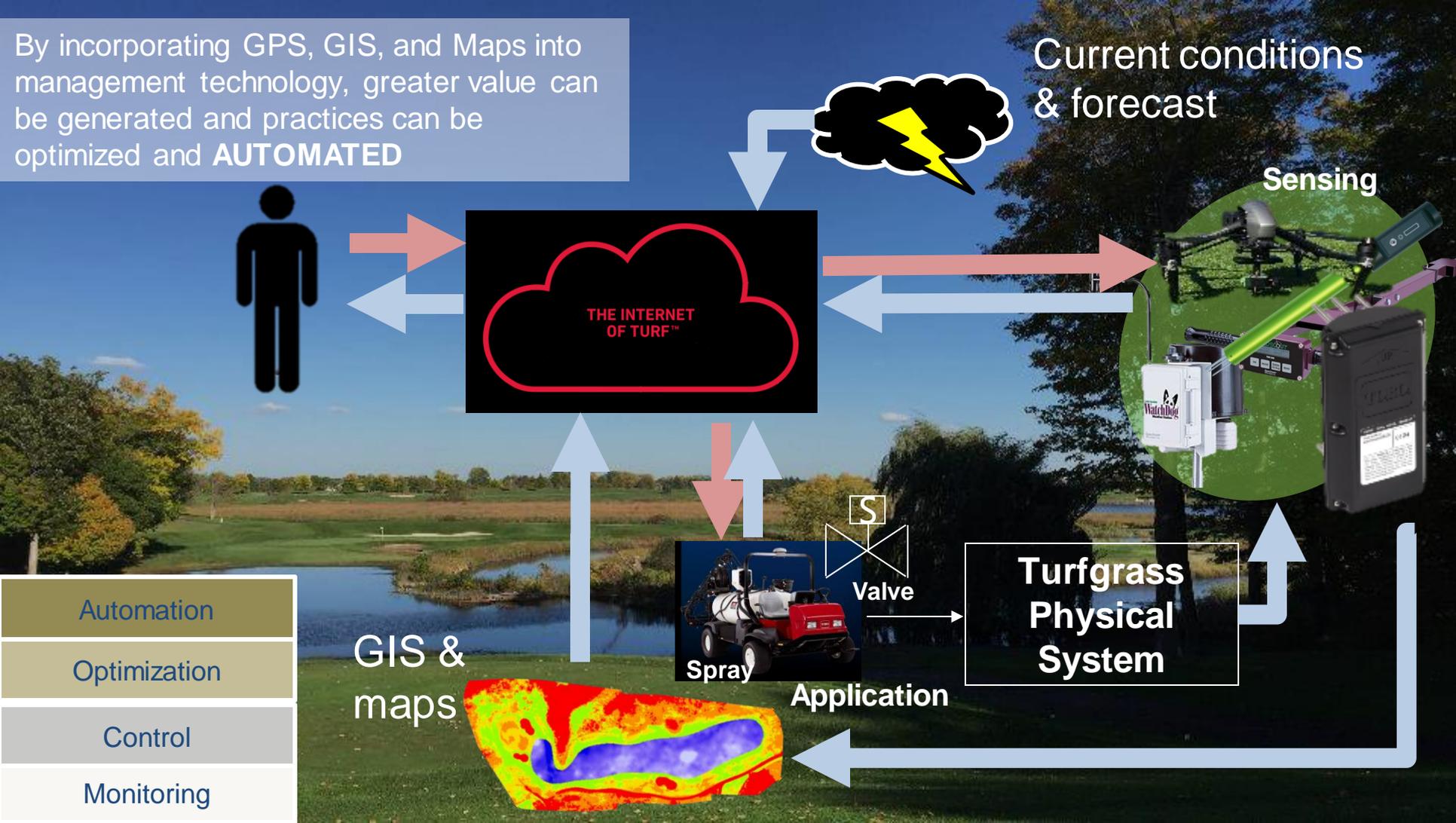
GIS & maps



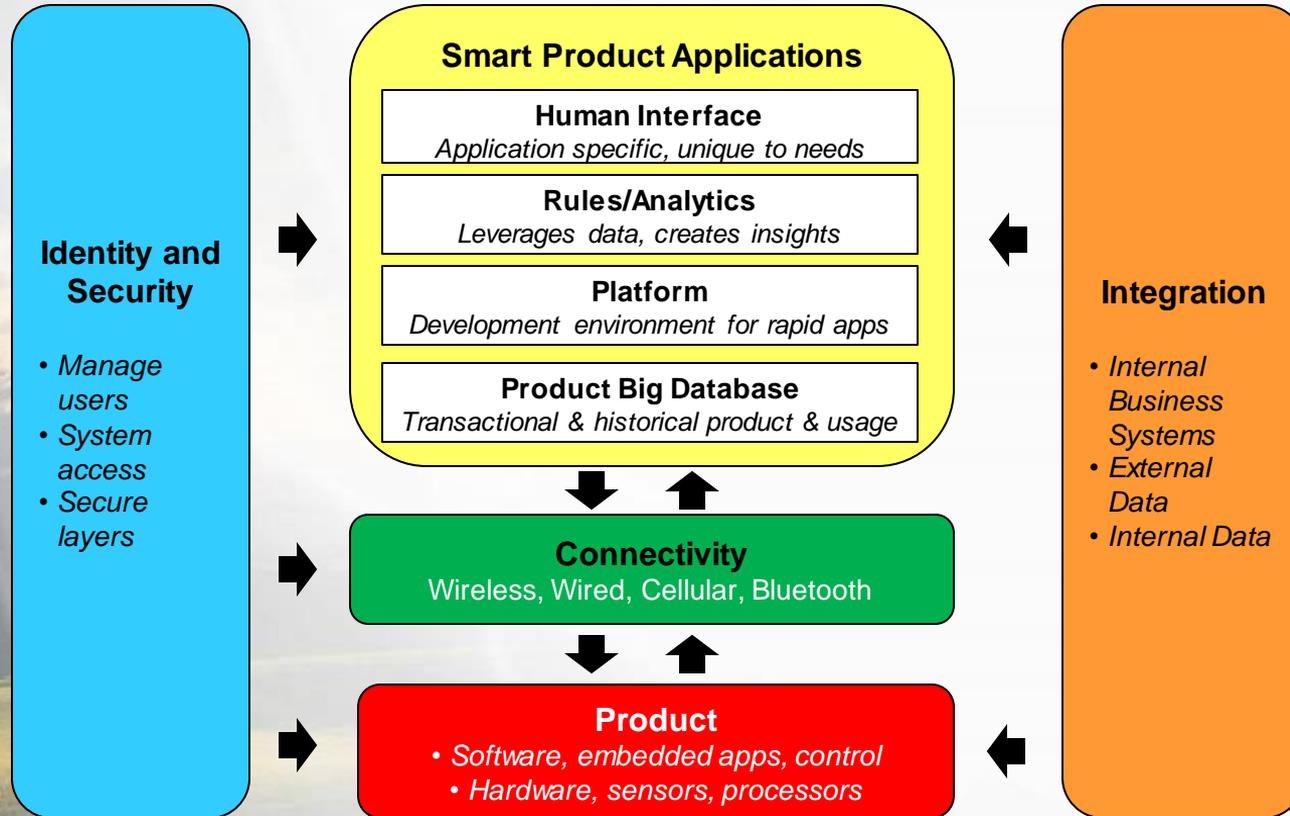
Valve



Application



# Smart Connected Products Technology Stack









# Robots, Robots, and More Robots!



# Not a Matter of If, but When!

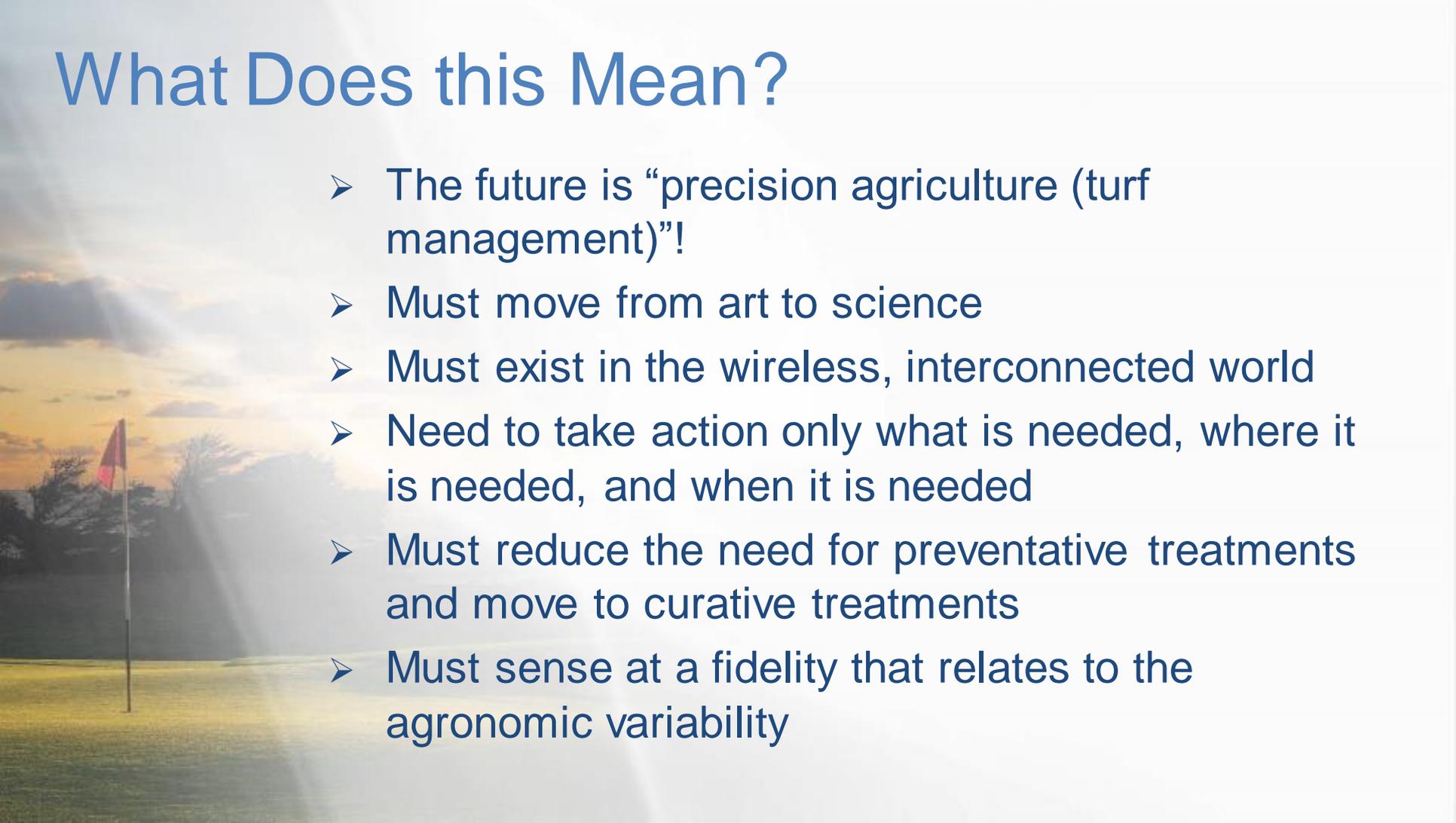
## Why is when now?

Cost of important enabling technology has come down orders of magnitude

- Digital imaging
- Inertial measurement unit
- Laser rangefinders
- Radar range sensors

# What Does this Mean?

- The future is “precision agriculture (turf management)”!
- Must move from art to science
- Must exist in the wireless, interconnected world
- Need to take action only what is needed, where it is needed, and when it is needed
- Must reduce the need for preventative treatments and move to curative treatments
- Must sense at a fidelity that relates to the agronomic variability



# Thank you!

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