

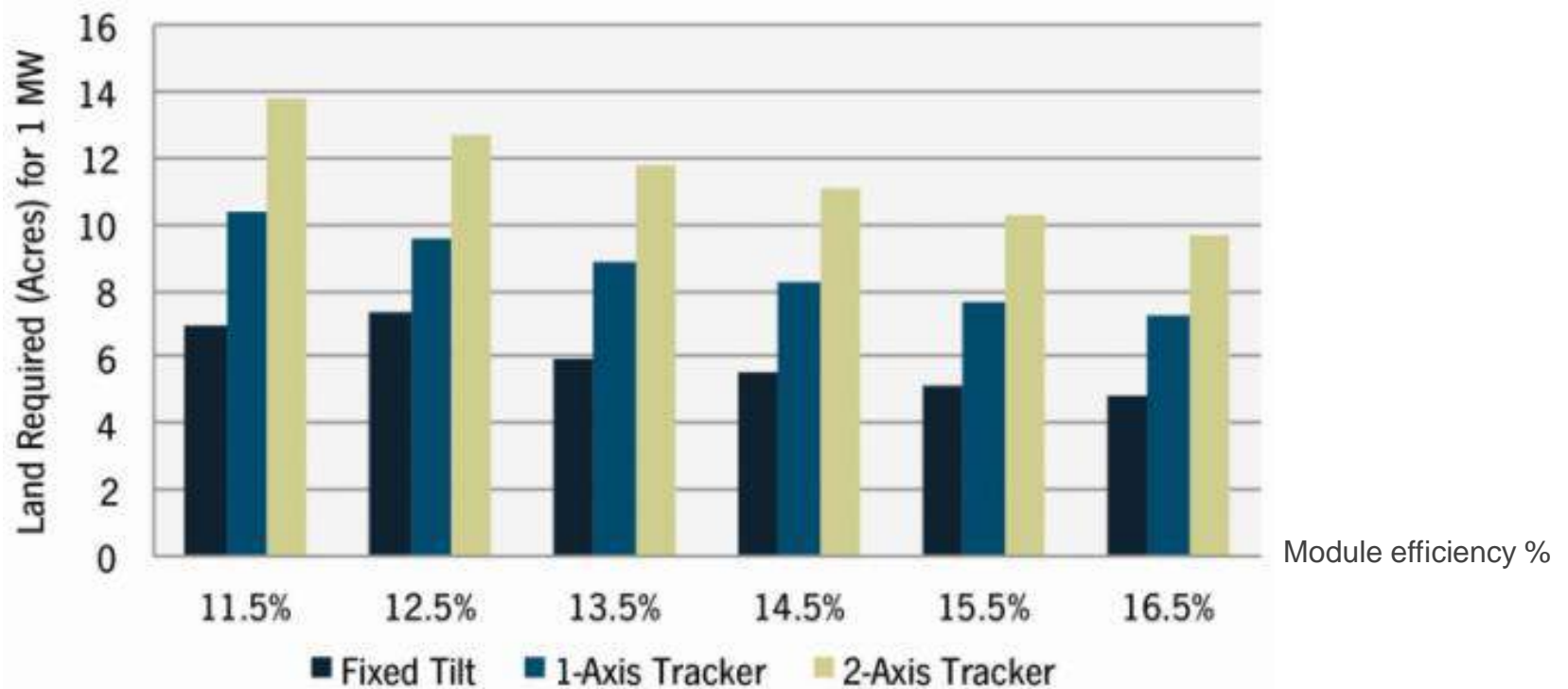
# Tracker Insight: The Future of Large Scale Solar?



# How Much Land Do You Need for Tracker

- Tracker requires about 50% more land than fixed tilt

Land Requirements by Mounting Structure Type & Module Conversion Efficiency

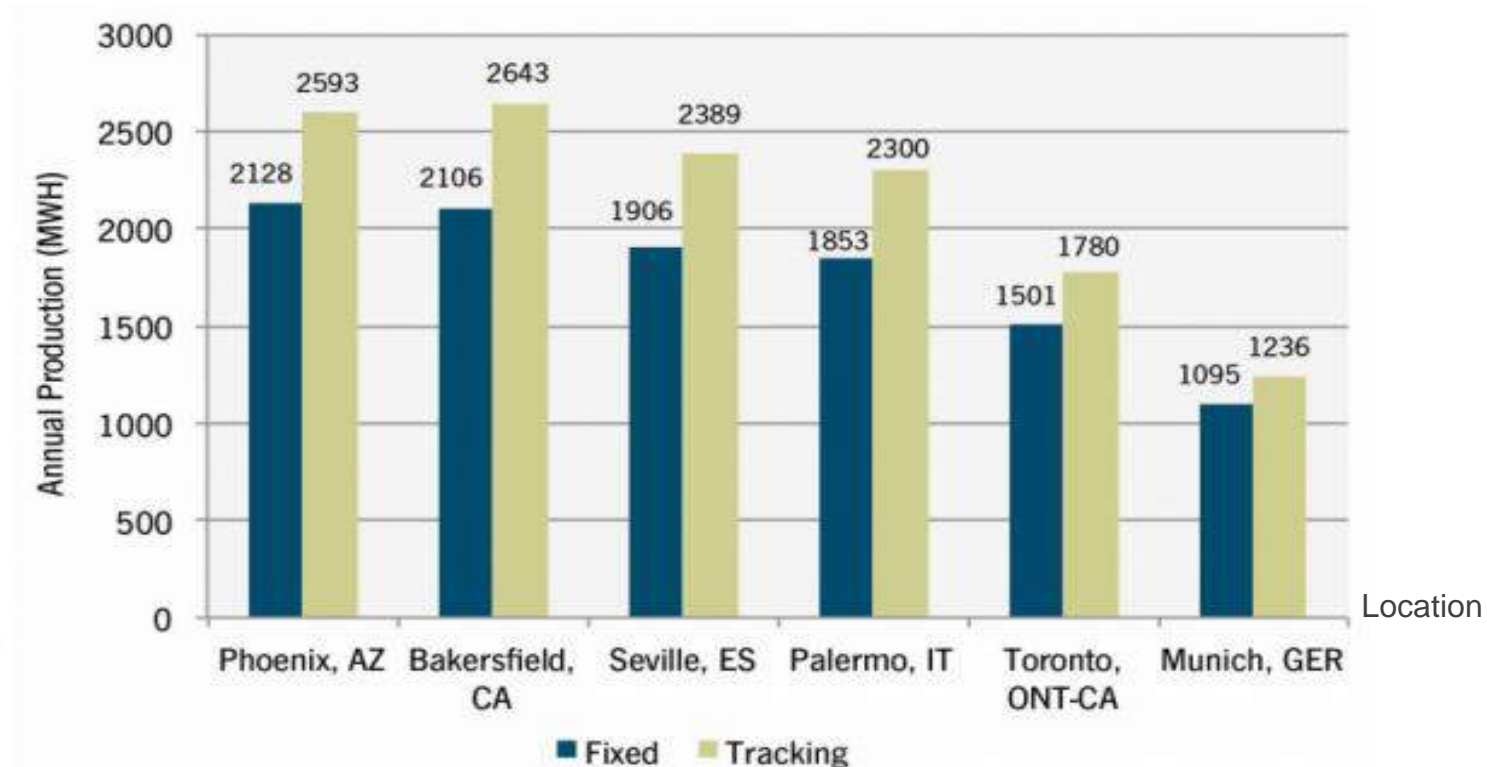


Source: Solar PV Balance of System (BOS) Markets: Technologies, Costs and Leading Companies, 2013-2016

# Tracker and Fixed Tilt Energy Comparison

- Single axis tracker produces about 20% more energy
  - Depends on location (direct normal irradiation (DNI))

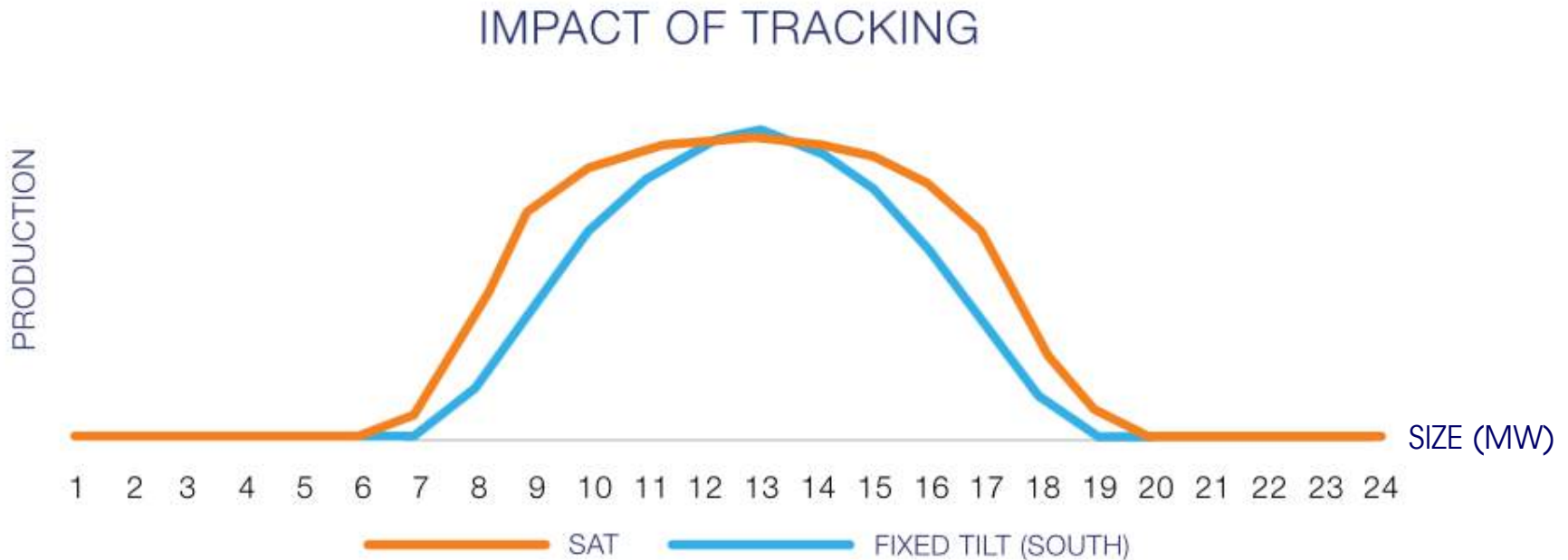
Efficiency Energy Harvest, 12.5 MW Fixed vs. 10 MW One-Axis Tracking



Source: Solar PV Balance of System (BOS) Markets: Technologies, Costs and Leading Companies, 2013-2016

# Making Energy When Utilities Need It - Trackers Smooth Energy Output

Added Production from Single Axis Tracking



Source: SEPA 2016

# Tracker Project Economics VS. Fixed Tilt

- Better energy yield – 15-25% more MWh/year/kw
- Fewer modules for the same energy output as fixed tilt
- Better average selling price/margin (though less so now that module prices are coming down)
- Better chance of shedding snow
- Less chances of soiling since it's constantly in motion and moves to greater tilt
- Better suited for larger projects (10MW+) - more scalable
- Cost more to build
- More complex engineering design



Picture: GameChange Genius Tracker™

# Tracker and Fixed Tilt Economics

Impact of System Design on LCOE for a 20 MW Solar Project (Phoenix AZ)

	FIXED TILT	SINGLE-AXIS TRACKING
CAPACITY FACTOR	30.5%	36.0%
BUILD COST	\$1.60/Watt-dc	\$1.68/Watt-dc
LCOE	\$63/MWh	\$55/MWh

Source: SEPA 2016

# Decentralized VS. Centralized

- Less O&M cost:
  - Easier to clean modules
  - Easier to cut grass
  - Easier to seed in case of erosion
  - Easier to drive through for inspection
- More flexibility with layout, for example, a non rectangular layout is possible
- Less concerns about terrain change
- No wires across the site for both power source and communication wires
- Less downtime
- Faster to install
- Fewer parts – less cost



Picture: GameChange Genius Tracker™

# GameChange Genius Tracker™ System

- Breakthrough technology enables lowest cost and highest reliability tracker with fastest install and lowest O&M cost
- Black & Veatch technical assessment, CPP wind tunnel tested and rated 150mph, ETL /UL 2703 tested
- Highest power density of any single axis tracker, 99.3% panel density on rows vs. 94.0% best competitor
- Robust linear actuator drive system has 40 year operating life and is IP 66 rated for operation in harsh environmental conditions
- Every drive actuator has its own battery backup and wirelessly linked controllers, eliminating all trenching, tru3d-gimbal™ bearings account for pile installation being out of plumb, out of azimuth and out of vertical & east-west alignment
- Self-powered rows eliminate central drive, allow for uninterrupted grass cutting and panel washing
- Free installation training and tracker commissioning
- 10 person crew installs over 1 mw trackers and panels per week



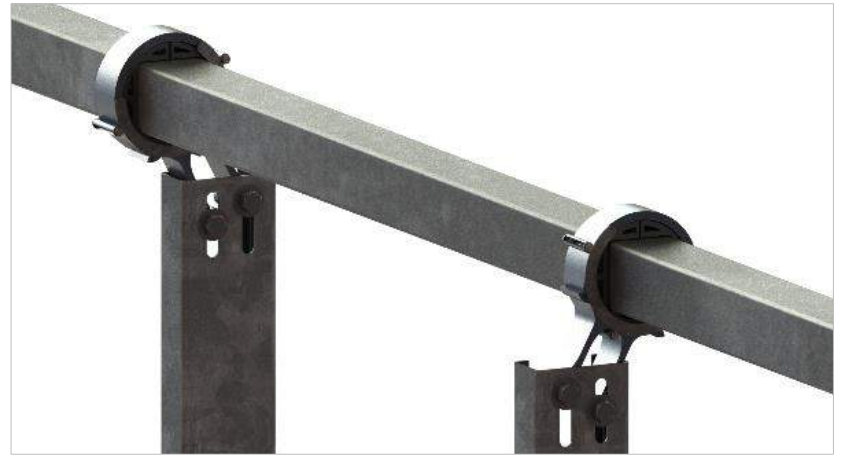
Picture: GameChange Genius Tracker™



# Fast Installation, Optimal Performance



Tru3D-Gimbal™ bearings allow for 4.5% plumbness & azimuth tolerance, 2" vertical & 1.5" east-west adjustment



Bearings pivot to allow for up 4 inches east-west adjustment

# Fast Installation, Optimal Performance



Linear actuator robust with 40 year operating life, IP 66 rated for operation in harsh environmental conditions

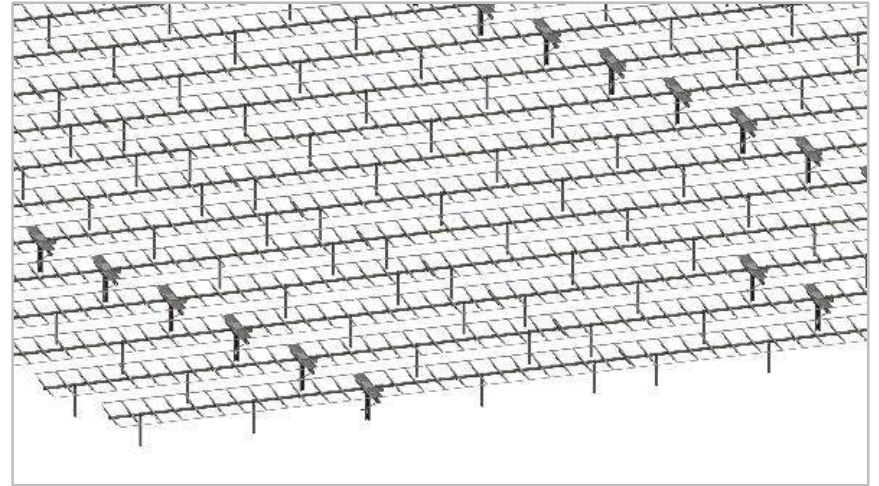


Purlins attach quickly onto row tubes

# Fast Installation, Optimal Performance



Mounts all poly and thin film modules including First Solar Series 4



Self powered rows eliminate central drive, allow for easy maintenance

# Genius Tracker™ System Features

- Encryption Protection: ZigBee® wireless network
- Tracking: Single axis horizontal
- Rotational Range (East/West): 90° standard 100° and 120° available
- Tracking Method: Time and location based algorithm (Based on NREL)
- Anti-Shading (Backtracking): Prevent panel shading for entire operational range
- Panel Mount: Large modules - portrait 1-2up, thin film First Solar series 4 modules-landscape 3-6up
- Array Configuration: Array may be built with complete flexibility in both east-west and north-south directions
- Table Length: Up to 90 72 cell modules driven by one actuator
- Slope Tolerance: Handles slopes north-south 7% and east-west of 13%

# Genius Tracker™ System Features

- Remote Communication: Secure monitoring and control tracker array in real-time via an encrypted cloud portal full stop; SCADA solution available
- System Power Density: Highest power density of any single axis tracker, 99.3% panel density on rows versus 94.0% best competitor
- Ground Coverage Ratio: 0.25 to 0.65 (IAs required)
- Stow Windspeed: Varies with time of day, averages 70 mph +. typical stow time less than 2 min
- O&M Cost: 65% lower vegetation O&M cost than center drive trackers by eliminating weed wacking along drivelines. Overall 10% lower O&M cost
- Smart Stow Technology: Minimalize stow downtime
- Backup Power: Every linear actuator has integrated solar panel and battery providing integrated backup - typically 5 days
- Drive Type: Linear actuator robust stainless steel & aluminum, 40yr. Life IP rated for operation in harsh environmental condition

# Genius Tracker™ System Features

- Linear Actuator Motor: 24 volt or 12 volt DC
- Controller: Microcontroller driven, field replaceable controller spares provided
- Control Board: PCB with standard semiconductors
- Warranty: 10yr structural components, 5yr warranty on control & drive systems (20yr/10yr also available)
- Grading Requirements: Least site grading required of any tracker system
- Monitoring: Operational alert emails and web portal for viewing site installations
- Parasitic Load: Zero draw on solar array - small solar panel charges battery
- Module Attachment: Bottom or top mount for framed and double glass modules
- Design Efficiency/Damping: Industry's highest intrinsic damping eliminates costly dampers and reduces material cost

# Genius Tracker™ System Features

## Test & Certification

- CPP wind tunnel tested and rated 150mph
- ETL/UL 2703 tested
- Black & Veatch technical assessment

## Calculations

- Site specific code compliant system structural calculation based on values for any location

## Material

- Post: G235 galvanized steel (or HDG option) channels, I beam option (HDG)
- Tubes, Purlins And Other Components: G90 galvanized steel
- Tracker Hardware: Magnacoat 3/8", 1/2" & 3/4" hex bolts, serrated flange hex nuts and washers, 1/2" & 3/4" threaded rods, 3/8" U bolts
- Panel Mounting Hardware: Stainless steel 1/4" - 20" serrated flange nuts 1/4" - 20" X 3/4" long bolts plus star washers for grounding
- Bearings: 6005A-T6 Aluminum and UV rated PP

Q & A

# Changing the Game for Single Axis Solar Trackers

