



# Advances in High Efficiency Technologies for TV

April 17, 2016

GatesAir Connect | NAB Show 2016

Featuring  
GatesAir's



Martyn Horspool  
Product Manager,  
TV Transmission

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# GatesAir - Milestones in Efficiency

- Decades of innovation and dozens of patents
- Early achievements in Radio transmitter efficiency (PDM, PSM and DX technology) 1970's to 1990's
- “Mod Anode Pulser” for Klystron transmitters (1980)
- 50V MOSFET VHF Transmitters (Platinum Series, 1988)
- Multi-Stage Depressed Collector IOT's (PowerCD)
- UHF LDMOS FET Transmitters (DiamondCD, 1998)
- First 50V LDMOS Transmitters (Maxiva ULX, 2009)
- High-efficiency broadband UHF Transmitters (Maxiva ULXT w/PowerSmart)
- Optimized High-efficiency UHF Transmitters (Maxiva ULXT w/PowerSmart™ Plus)



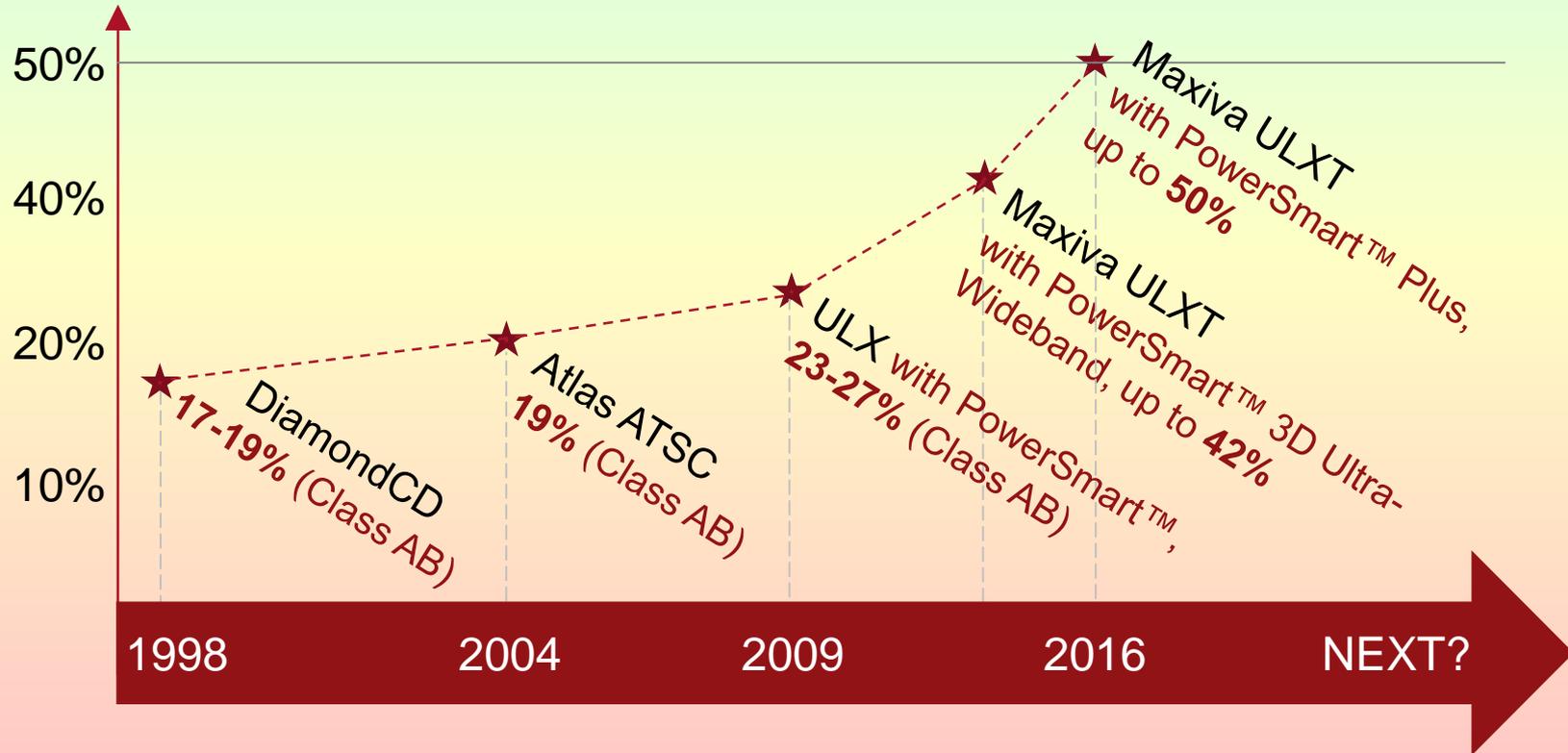
**1979**  
SX-5 Poly-Phase  
PDM 5kW AM  
Transmitter - 75%  
Efficiency



**2016**  
Maxiva ULXT with  
PowerSmart™ Plus  
DTV Transmitter  
Up to 50% ATSC  
efficiency

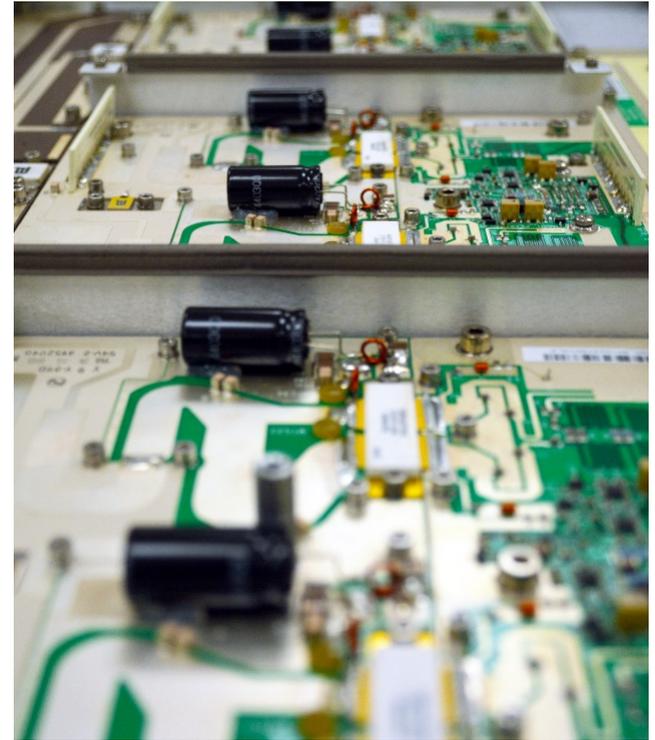


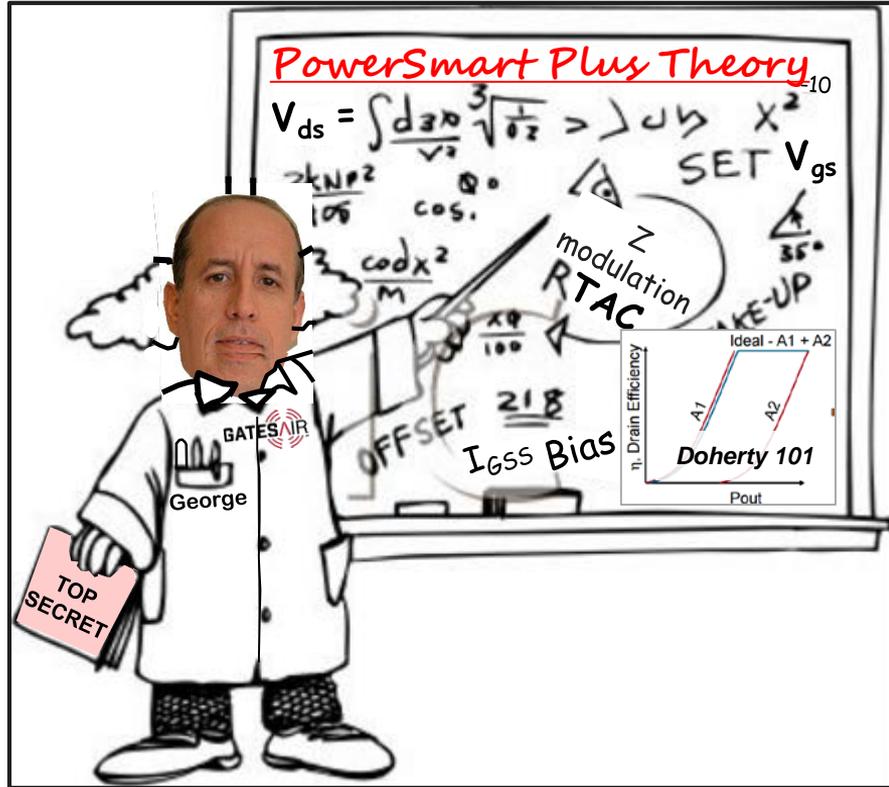
# GatesAir Solid State ATSC Efficiency Timeline



- PowerSmart® – An on-going initiative at GatesAir to improve efficiency & lower cost of ownership
- PowerSmart® 3D provided fully broadband, high efficiency solutions allowing dramatic power reduction
- PowerSmart® Plus uses several new techniques to further optimize efficiency

***AND ITS NOT JUST THE AMPLIFIER!***





- Provides an alternative to fully broadband
- Three bands cover all of UHF
  - Two bands for USA ch14-51
- Main design changes:
  - Narrower band range for pallet (3)
  - Optimized impedance balance (3:1, vs. 2:1)
  - New XTE exciter with superior pre-correction, allows:
    - Adjust LDMOS Drain Voltage
    - Optimize Bias Voltage

- PowerSmart<sup>®</sup> Plus Delivers up to 50% Efficiency
  - Improved Performance vs. Ultra-Wideband
    - Dramatic 8 - 12% point gain in efficiency
  - Band A - Up to Channel 34
  - Band B - Up to Channel 55
  - Band C - Up to Channel 64
  - > 100MHz bandwidth per band
- Includes recent updates, being implemented
  - XTE Exciter
  - Advanced Real Time Adaptive Correction (RTAC)

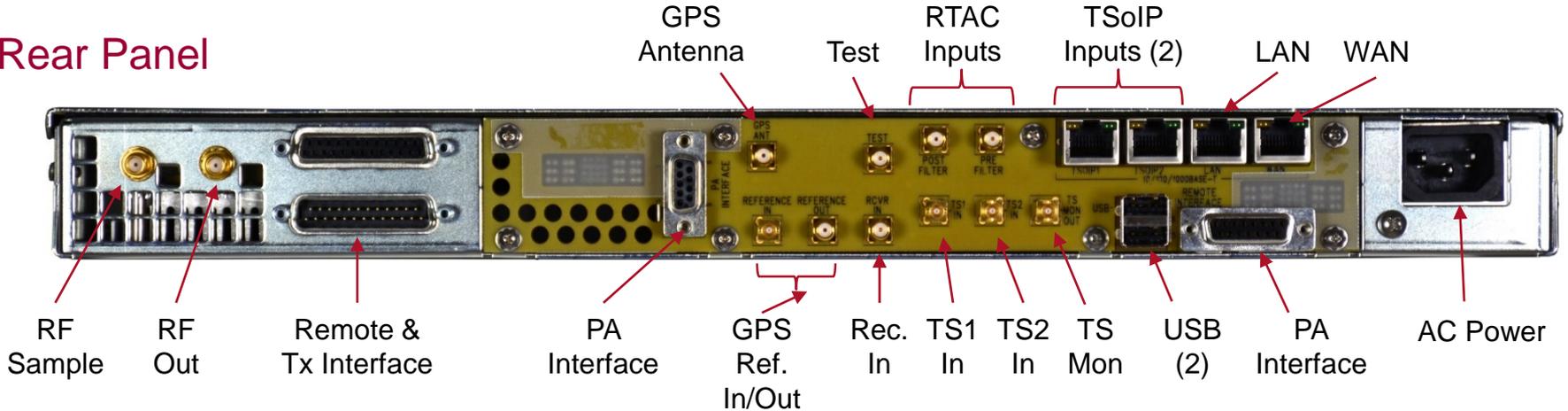


# XTE Exciter

## Front Panel



## Rear Panel



# XTE Exciter

- XTE Exciter
  - ATSC 3.0 Ready
  - Dual modulations stored (e.g. ATSC 1.0/3.0)
  - Native TSolP inputs (dual redundant)
  - ASI/SMPTE310 Inputs (dual redundant)
  - Improved battery UPS with front access
  - 1 RU package
  - Earlier excitors can be retrofitted with XTE
  - Advanced Real Time Adaptive Correction
    - Much better correction range, can correct Doherty PA's and Drivers
    - Adaptation time (to spec) is only 8.3 seconds, versus 74.6 seconds with M2X
    - Provides better performance and efficiency (Doherty PA at best efficiency needs more pre-correction)



# New XTE Web GUI

- Home Screen, Exciter running with no faults

The screenshot displays the Maxiva XTE web GUI interface. At the top, it shows the user 'gates, Engineer' and the device 'Mason R&D Model 00001'. The main dashboard includes several sections:

- Power Controls:** A green power button labeled 'On', a 'Logout' button, and buttons for 'Menu' and 'Event Log'.
- Power Levels:** 'Forward' power is shown as a green bar at 100mW, and 'Foldback' is at 0%.
- RTAC Status:** A table showing RTAC (Radio Transmitter Activity Control) status for Linear, Nonlinear, Bypass, Hold, Air, Mute, and Remote. The 'Status' column shows 'Main OK' and 'Summary Warning'.
- Performance:** Shows LSB: -54.7 dB and USB: -53.7 dB.
- Input Status:** A table showing Primary and Secondary inputs are OK, with Active Input set to Primary (ASI 2).
- Exciter Home Diagram:** A central diagram with 'Exciter Home' in a blue bar. It shows 'Input Settings', 'Power Supplies', and 'Battery Backup' connected to an 'ATSC Modulator' and 'RTAC' block. The 'ATSC Modulator' is connected to 'Output', 'Transmitter I/O', and 'FTR'. A 'Power' display shows 100 mW.
- Spectrum Plot:** A graph titled 'Spectrum Plot' showing a signal between -4 MHz and 4 MHz with a peak around 0 dB.
- Active Events:** A section at the bottom with a 'More' button.

# New XTE Web GUI

- Home Screen with a fault displaying the most recent fault in the collapsed Active Events bar

The screenshot displays the Maxiva XTE web GUI interface. At the top, it shows the user 'gates, Engineer' and the device 'Mason R&D Model 00001'. The interface includes several control panels: a power control panel with 'On', 'Logout', 'Menu', and 'Event Log' buttons; a status panel with 'Forward' (100mW) and 'Foldback' (0%) indicators; and a 'Performance' section with 'RTAC' and 'Status' sub-sections. A central 'Exciter Home' diagram shows the signal flow from 'Input Settings' through 'ATSC Modulator' and 'RTAC' to 'Output', with 'Power Supplies' and 'Battery Backup' connected to the 'ATSC Modulator'. A 'Spectrum Plot' on the right shows a signal between -4 and 4 MHz. At the bottom, a red 'Active Events' bar displays the message: '03/09/2016 20:56:51 - RF UpConverter Power'.

# New XTE Web GUI

- Faults/  
Warnings displayed
- Help &  
Glossary also displayed

The screenshot displays the Maxiva XTE web GUI interface. At the top, it shows the user 'gates, Engineer' and 'Mason R&D' with 'Model 00001'. The main area is divided into several sections:

- Input Status:** Shows Primary, Secondary, Active Input, Primary Input, and Secondary Input, all with 'OK' status.
- Forward/Foldback:** A progress bar for Forward (100mW) and Foldback (0%).
- RTAC Performance:** Shows Linear, Nonlinear, Air, Mute, Summary, and Remote status.
- ATSC Section:** Includes 'ATSC' mode, 'A/110 Version' (A/110:B), 'Transmitter Signaling' (Tier ID: 7, TX ID: 0), and 'Antenna Delay' (0).
- Test Mode:** Shows 'Pilot Test Tone' (Off) and buttons for 'Transport Stream' and 'DTX/SFN'.
- Active Events:** A table listing recent faults and warnings.
- Help and Glossary:** A pop-up window on the right providing detailed information about 'Mute on Loss of TS', 'Network Operation', 'Network ID', 'ATSC Mobile DTV', 'FRSC', 'A/110 Version', and 'Tier ID'.
- Spectrum Plot:** A graph showing signal levels across a frequency range from -6 MHz to 6 MHz.

Time	Type	Message
03/15/2016 12:55:20	FAULT	PA Temperature
03/15/2016 12:53:28	WARNING	FTR Holdover Not Possible
03/15/2016 12:50:11	WARNING	FTR PII Undisciplined
03/15/2016 12:50:11	WARNING	FTR PII HighGain
03/15/2016 12:50:11	FAULT	FTR EXT 1PPS
03/15/2016 12:50:11	FAULT	FTR GPS 1PPS
03/15/2016 12:50:11	FAULT	Battery
03/15/2016 12:47:40	WARNING	Pre-Filter Input Level Low



# High Efficiency - What's Next?

- GatesAir continues to investigate further efficiency enhancements and other technologies. What we are looking at:
  - Studying feasibility of alternate Power Amplifier designs
  - Enhanced or improved pre-correction techniques
  - Further optimize cooling efficiency
  - Envelope Tracking? – So far cost/complexity outweighs efficiency gains
  - New technology RF devices – work closely with device manufacturers
  - New developments in Power Supply technology
  - Test every idea/concept before bringing them to market
  - Always keep *Total Cost of Ownership* in mind
    - Highest efficiency isn't necessarily going to provide lowest Cost of Ownership....



# GatesAir ATSC Efficiency Comparison

*Includes IOT Systems*



17-19%



19%



Up to  
27%



27-29%



Up to  
41%



Up to  
42%



Up to  
50%

From Diamond to ULXT > 60% AC Power Savings



# How Much Power Can I Save?

## Electrical Power Savings Calculator

Maxiva ULXT with PowerSmart Plus vs. earlier GatesAir UHF Transmitters

Power Costs per EIA: [https://www.eia.gov/electricity/monthly/epm\\_table\\_grapher.cfm?t=epmt\\_5\\_6\\_a](https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a)

Transmitter Model	Maxiva ULXT with PowerSmart Plus	DiamondCD	Atlas ATSC	Maxiva ULX	SigmaCD	Maxiva ULXT w/ PowerSmart 3D
Enter transmitter pre-filter power (kW)	20					
Transmitter AC-RF efficiency	Up to 50%	Typ. 17-19%	Typ. 19%	Typ. 25%	Typ. 29%	Up to 42%
Transmitter power consumption (kW)	41.67	114.29	105.26	80.00	68.97	52.63
Select state from drop down list (USA)	California					
Average electricity cost per kW-hr	\$0.178					
Transmitter electricity cost per hour (USD)	\$7.40	\$20.30	\$18.69	\$14.21	\$12.25	\$9.35
Transmitter electricity cost per day (USD)	\$177.60	\$487.13	\$448.67	\$340.99	\$293.96	\$224.34
	\$0.00	\$0.00	\$0.00	\$0.00	\$1.00	\$0.00
Transmitter electricity cost per year (USD)	\$47,108	\$129,212	\$119,011	\$90,448	\$77,973	\$59,505
Transmitter electricity cost for 5 years	\$235,542	\$646,058	\$595,053	\$452,241	\$389,863	\$297,527
Transmitter electricity cost for 10 years	\$471,084	\$1,292,116	\$1,190,107	\$904,481	\$779,725	\$595,053
Transmitter electricity cost for 15 years	\$706,626	\$1,938,174	\$1,785,160	\$1,356,722	\$1,169,588	\$892,580



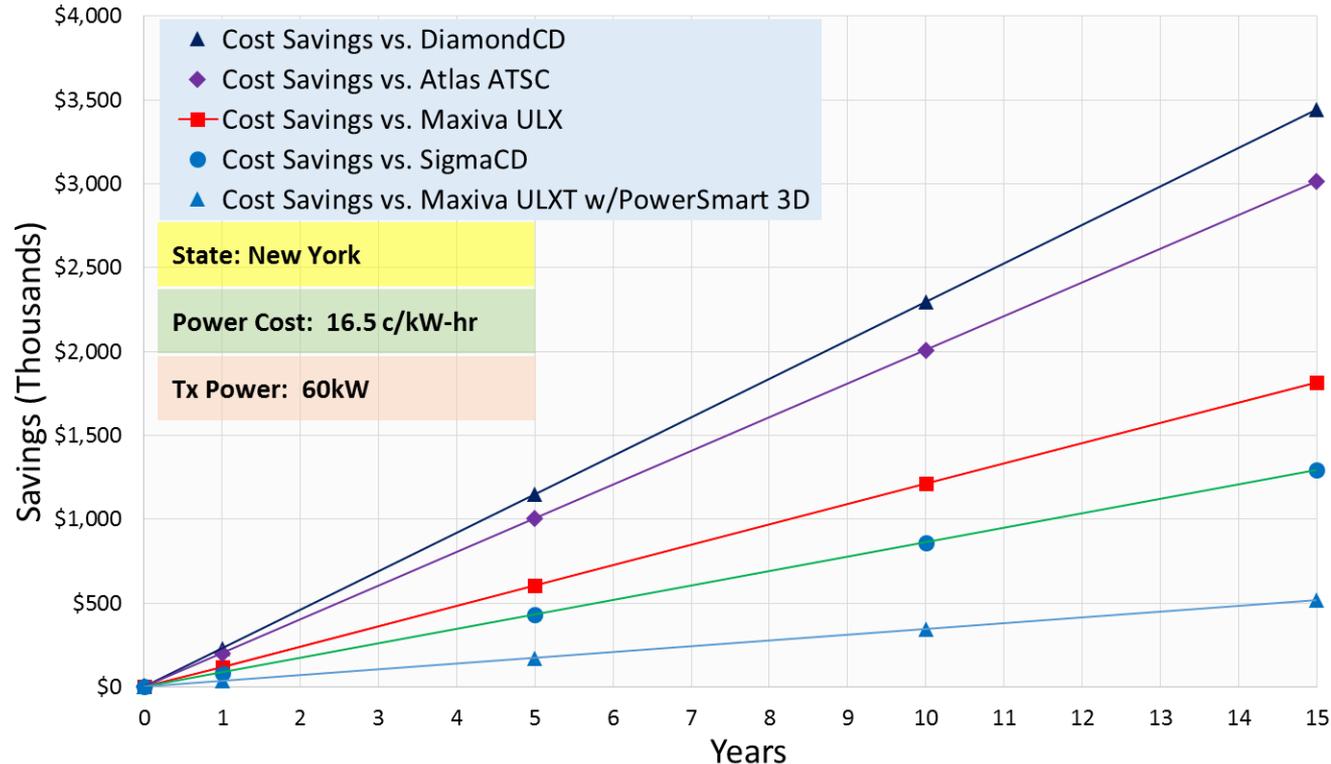
# Estimated Power Savings

## Example 1

- New York
- Average Power Cost: 16.5 c/kW-hr
- Tx Power 60kW
- Savings \$86k per year vs. SigmaCD
- No tubes to replace
- No high voltage



### Estimated Power Savings with PowerSmart Plus

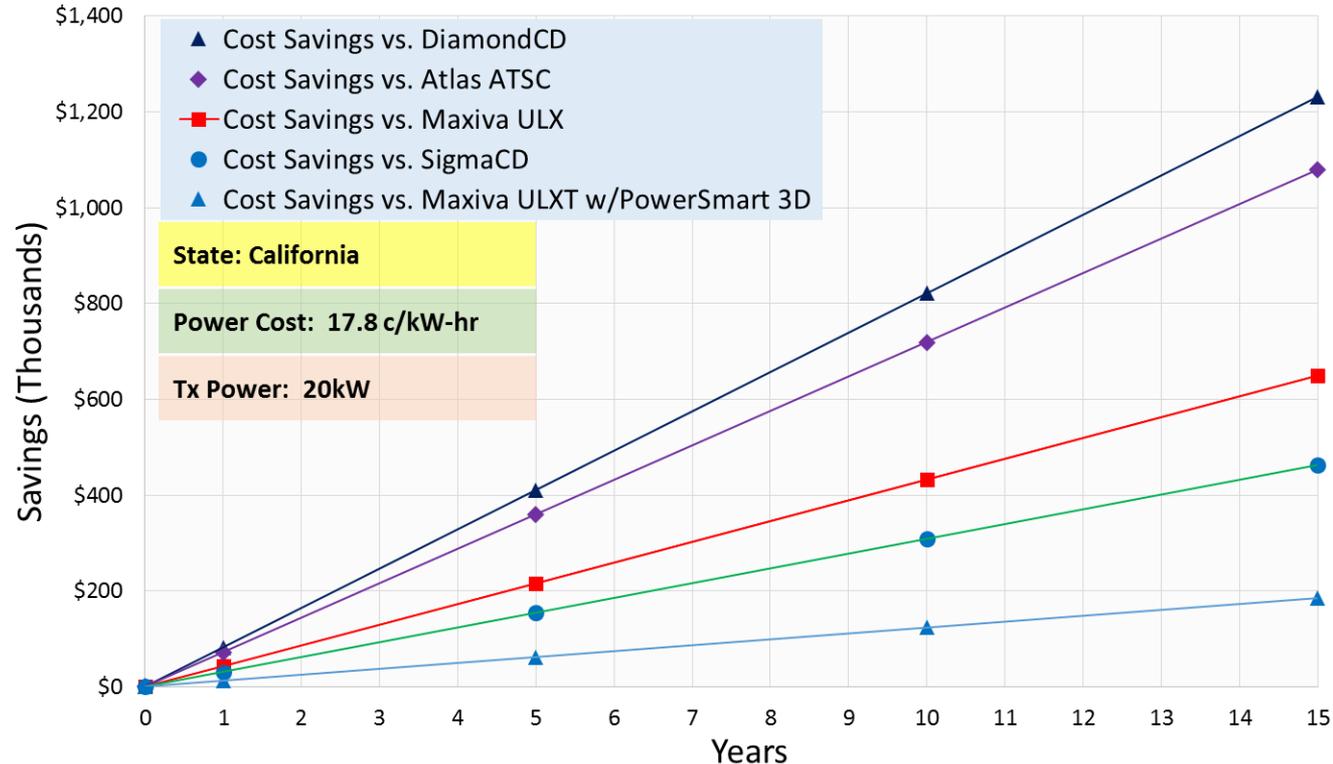


# Estimated Power Savings

## Example 2

- California
- Average Power Cost: 17.8 c/kW-hr
- Tx Power 20kW
- Savings \$82k per year compared to Diamond
- Plus additional saving for HVAC etc.

Estimated Power Savings with PowerSmart Plus



# Final Thoughts on Efficiency

- Obviously, the transmitter has the biggest impact on overall system efficiency
- But also consider:
  - AC power devices ahead of transmitter – Transformers, AVR, UPS, etc. Losses affect efficiency and heat load to room adds to cost of cooling
  - Transmitter heat load to the room (HVAC cost can be considerable)
  - Cooling system – variable speed pumps/fans can help optimize for seasonal variations
  - RF system losses – Low pass filters (0.1 to 0.2dB), Mask filters (0.25 to 0.6dB)
  - The size of line going up to the antenna makes a big difference
  - Example, requirement is for **20kW** average power to the antenna input:
    - 1,000ft of 4" 50 ohm line is 66.8% efficient – you need **29.9kW** tx TPO after mask
    - 1,000ft of 6" 75ohm line is 78.6% efficient – you need **25.4kW** tx TPO after mask
    - 6" line reduces transmitter power by 15% (and reduces energy bill by approx. 15%)



# Thank You!

Martyn Horspool  
GatesAir

