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)

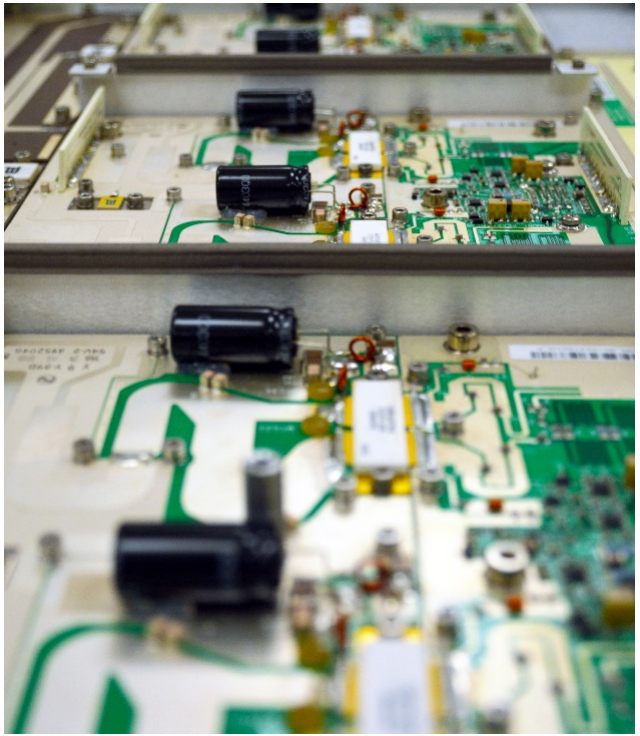
1979
SX-5 Poly-Phase PDM 5kW AM Transmitter - 75% Efficiency

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

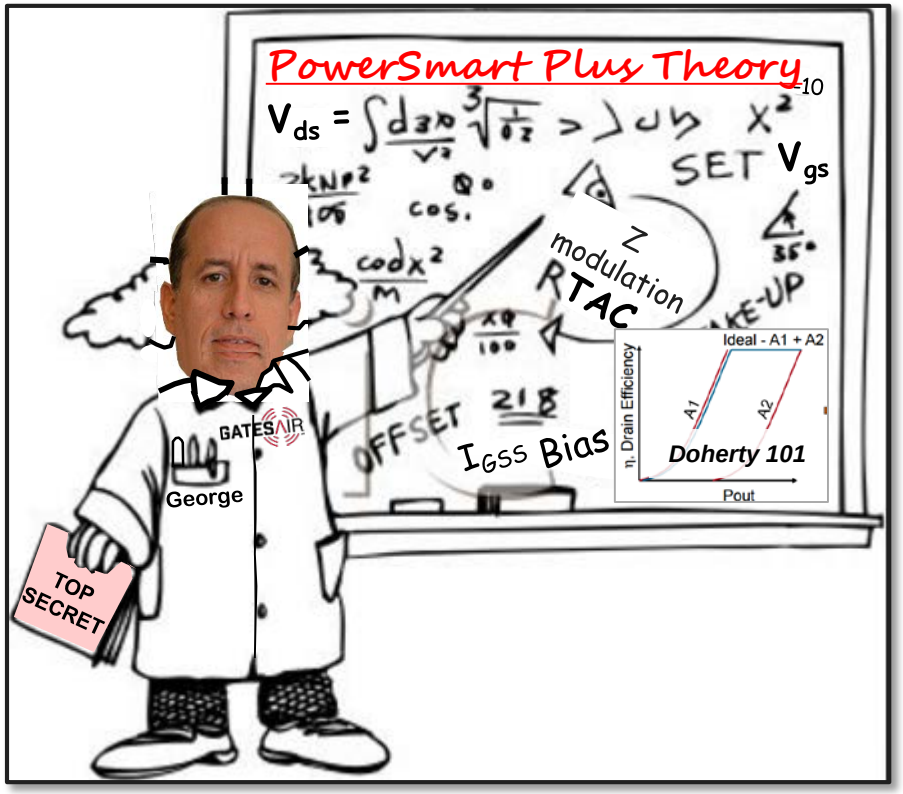
GatesAir Solid State ATSC Efficiency Timeline

- 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!



PowerSmart® Plus - What is it?

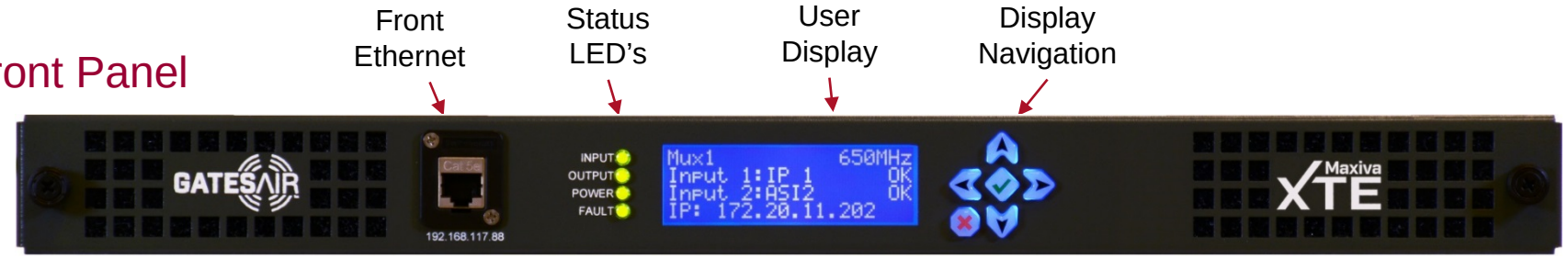


- Provides an alternative to fully broadband
- Three bands cover all of UHF
  - Two bands for USA ch14-51
- Main design changes:
  - Narrower band range for pallet (3)
  - Optimized impedance balance (3:1, vs. 2:1)
  - New XTE exciter with superior pre-correction, allows:
    - Adjust LDMOS Drain Voltage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

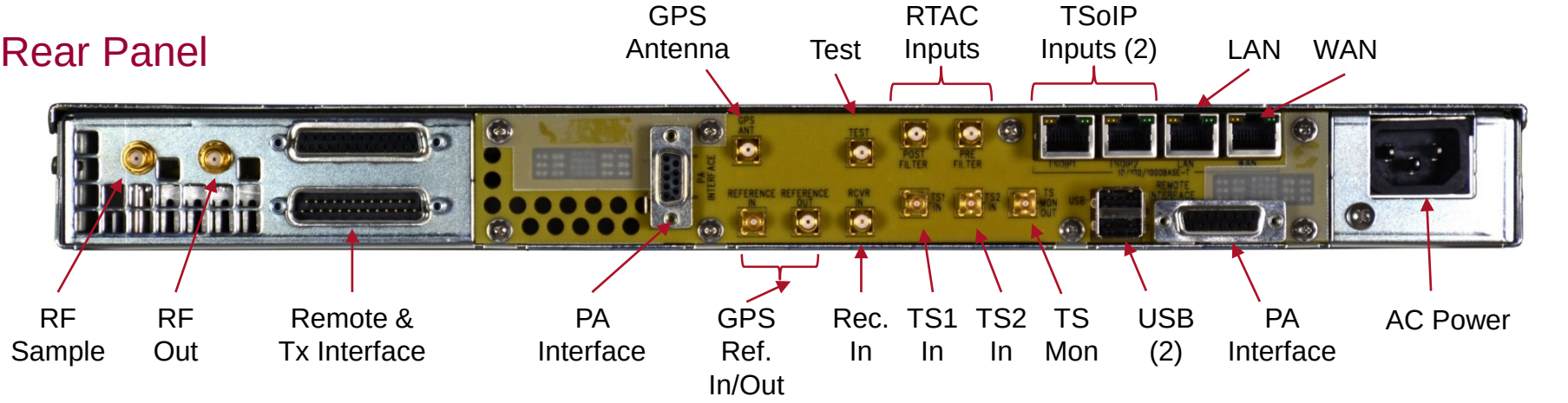
- PowerSmart® Plus Delivers up to 50% Efficiency
  - Improved Performance vs. Ultra-Wideband
    - Dramatic 8 - 12% point gain in efficiency
  - Band A - Up to Channel 34
  - Band B - Up to Channel 55
  - Band C - Up to Channel 64
  - > 100MHz bandwidth per band
- Includes recent updates, being implemented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

XTE Exciter

Front Panel



Rear Panel

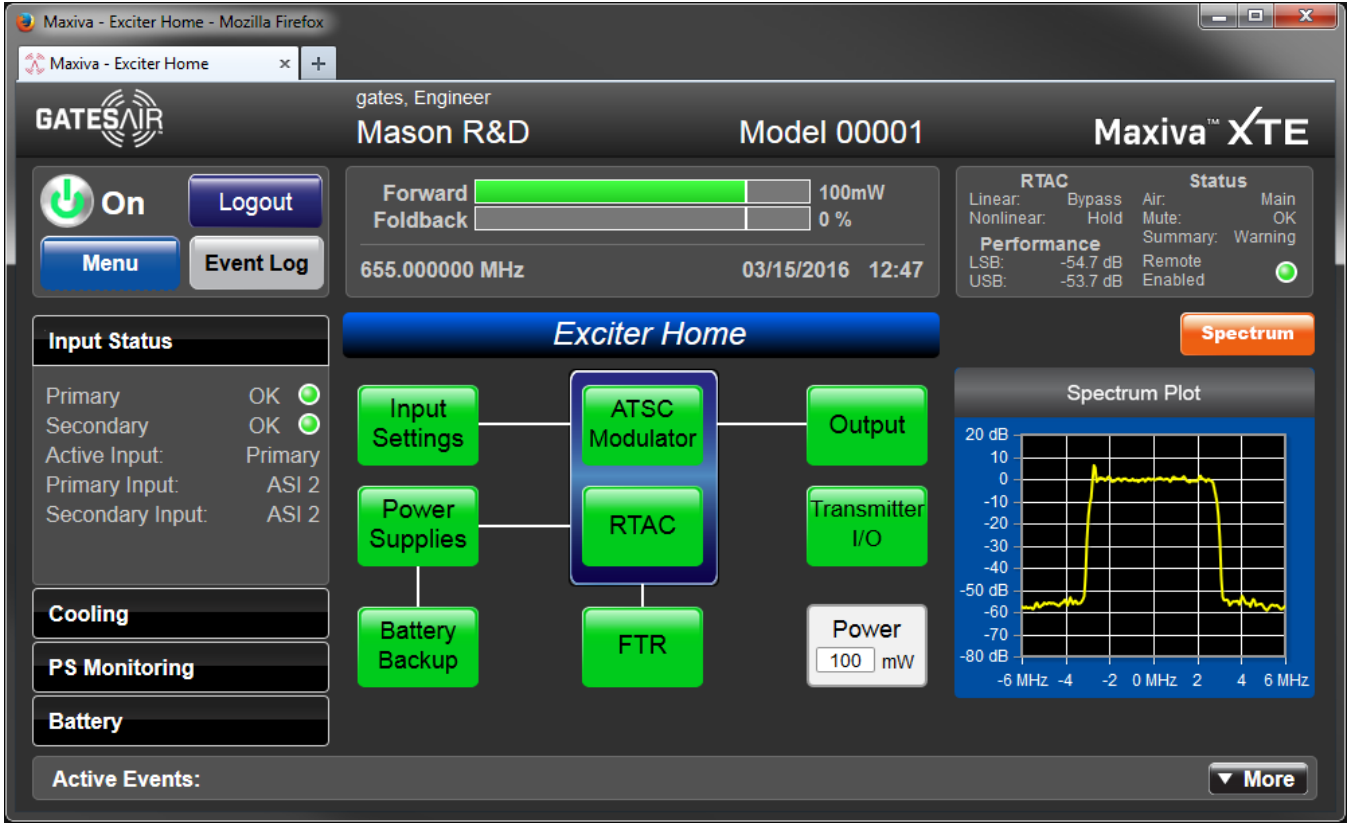


XTE Exciter

- XTE Exciter
  - ATSC 3.0 Ready
  - Dual modulations stored (e.g. ATSC 1.0/3.0)
  - Native TSoIP inputs (dual redundant)
  - ASI/SMPTE310 Inputs (dual redundant)
  - Improved battery UPS with front access
  - 1 RU package
  - Earlier exciters 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)

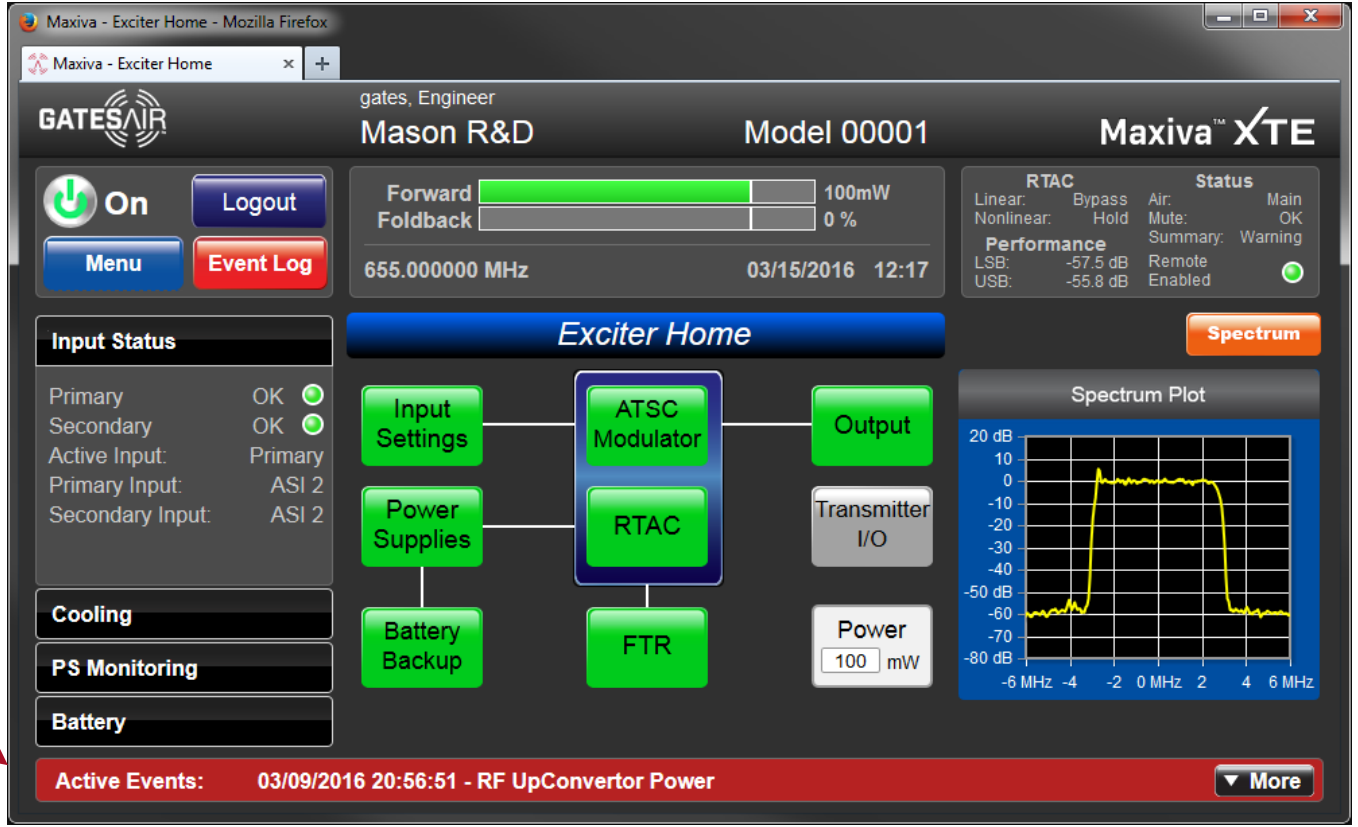
New XTE Web GUI

- Home Screen, Exciter running with no faults



New XTE Web GUI

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



New XTE Web GUI

- Faults/ Warnings displayed
- Help & Glossary also displayed

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

DiamondCD

17-19%

Atlas ATSC

19%

Maxiva ULX

Up to 27%

SigmaCD

27-29%

PowerCD

Up to 41%

Maxiva ULXT PowerSmart3D

Up to 42%

Maxiva ULXT PowerSmart Plus

Up to 50%

From Diamond to ULXT > 60% AC Power Savings

How Much Power Can I Save?

GATESAIR NABSHOW Where Content Comes to Life

Electrical Power Savings Calculator

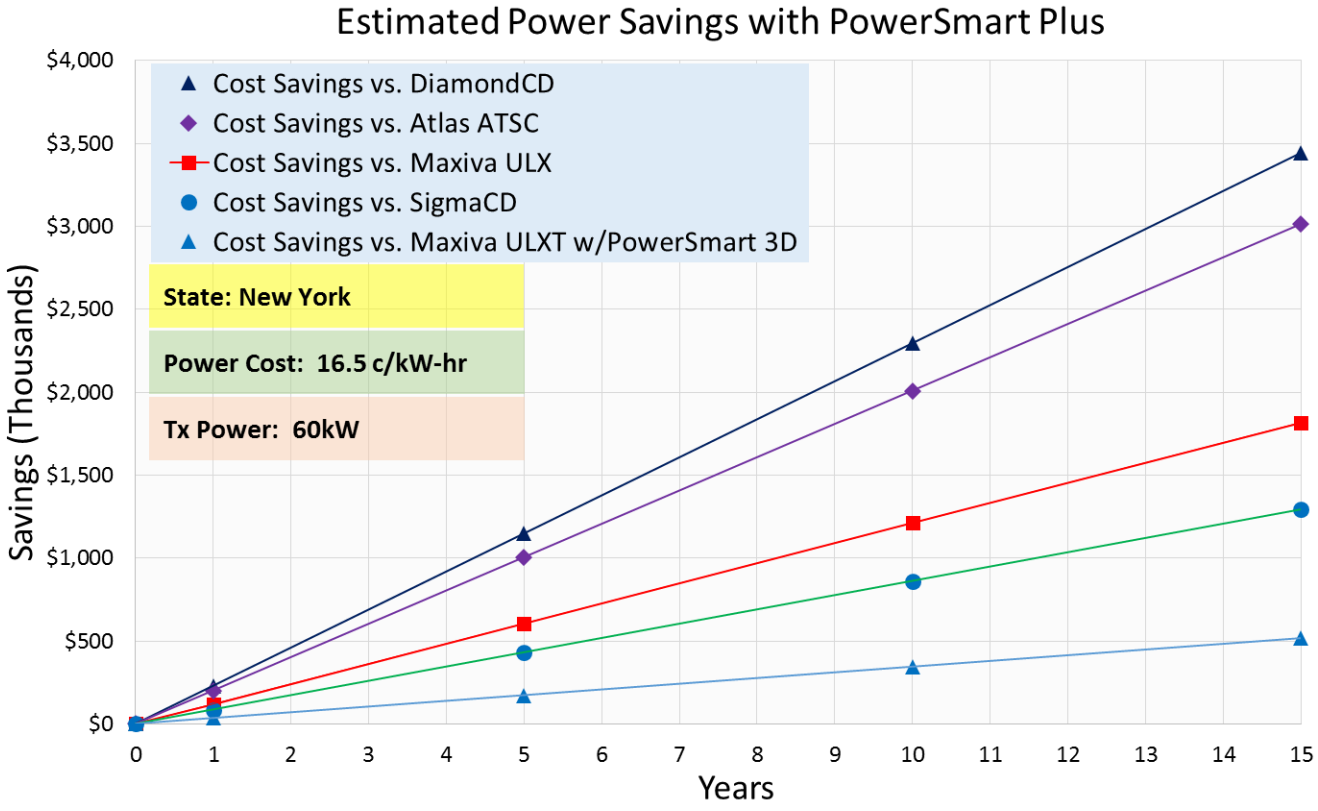
Maxiva ULXT with PowerSmart Plus vs. earlier GatesAir UHF Transmitters
Power Costs per EIA: https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a

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 elecricity 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

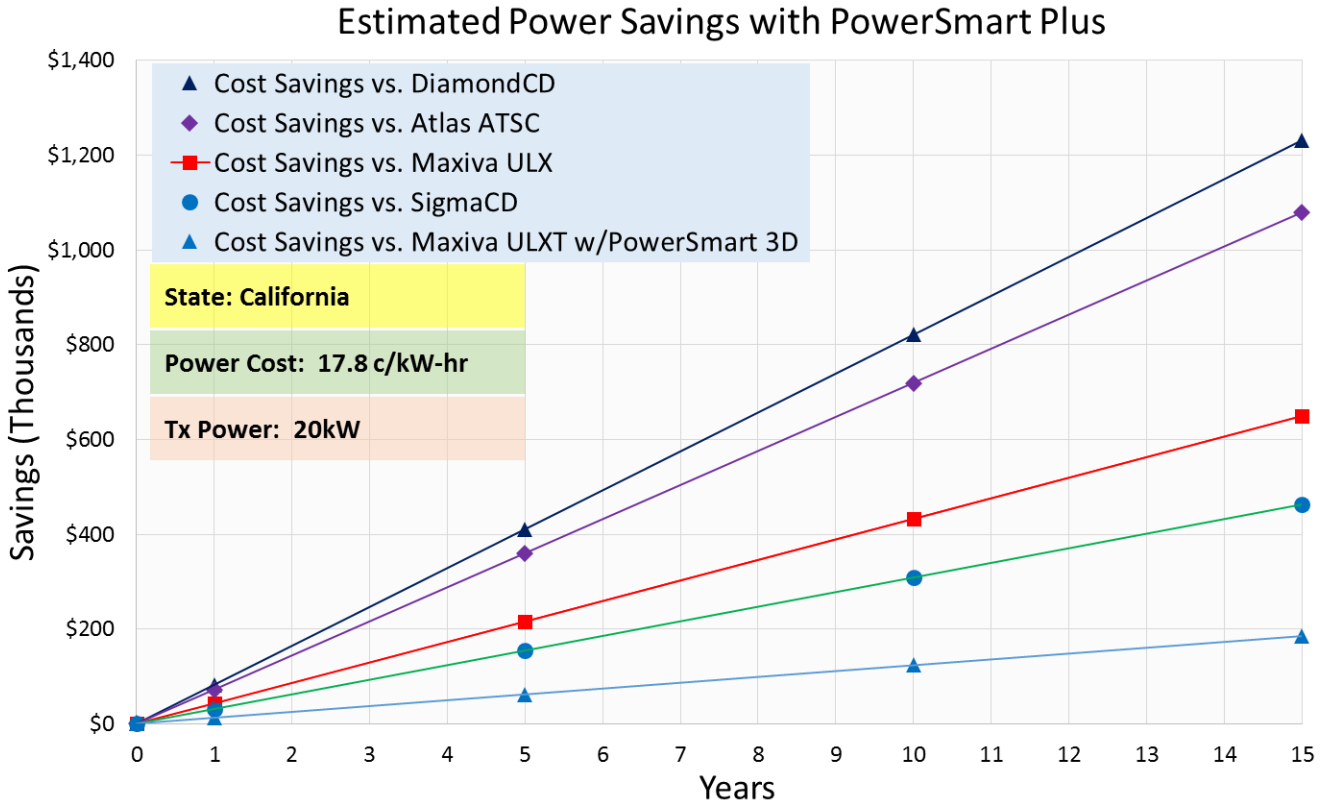
- New York
- Average Power Cost: 16.5 c/kW-hr
- Tx Power 60kW
- Savings $86k per year vs. SigmaCD
- No tubes to replace
- No high voltage



Estimated Power Savings

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.



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