



Total Cost of Ownership

Technologies for Optimized Transmitter Systems

April 12, 2015

NAB Show 2015

Featuring
GatesAir's



Martyn Horspool
Product Manager,
TV Transmission

NAB 2015

Total Cost of Ownership – Technologies for
Optimized Transmitter Systems

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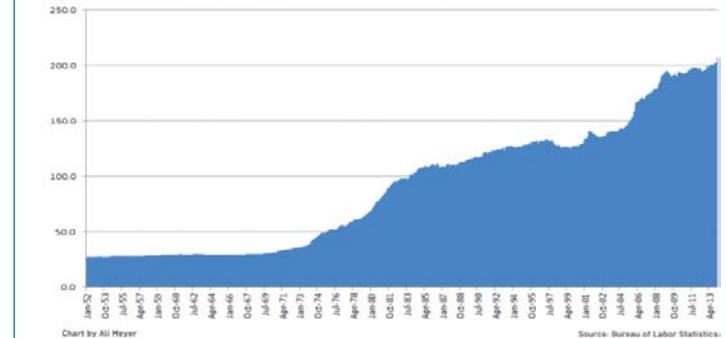
Issues Customers are Facing

Rising Cost of Energy

- World electricity prices have increased by an average of 6.6% per year for the past 5 years
- Projected to continue to rise throughout the world - 60% increase by 2030



Electricity Prices Hit all Time High



Carbon Taxes

- Some countries are imposing taxes based on energy usage, example Australia from 2012-14:

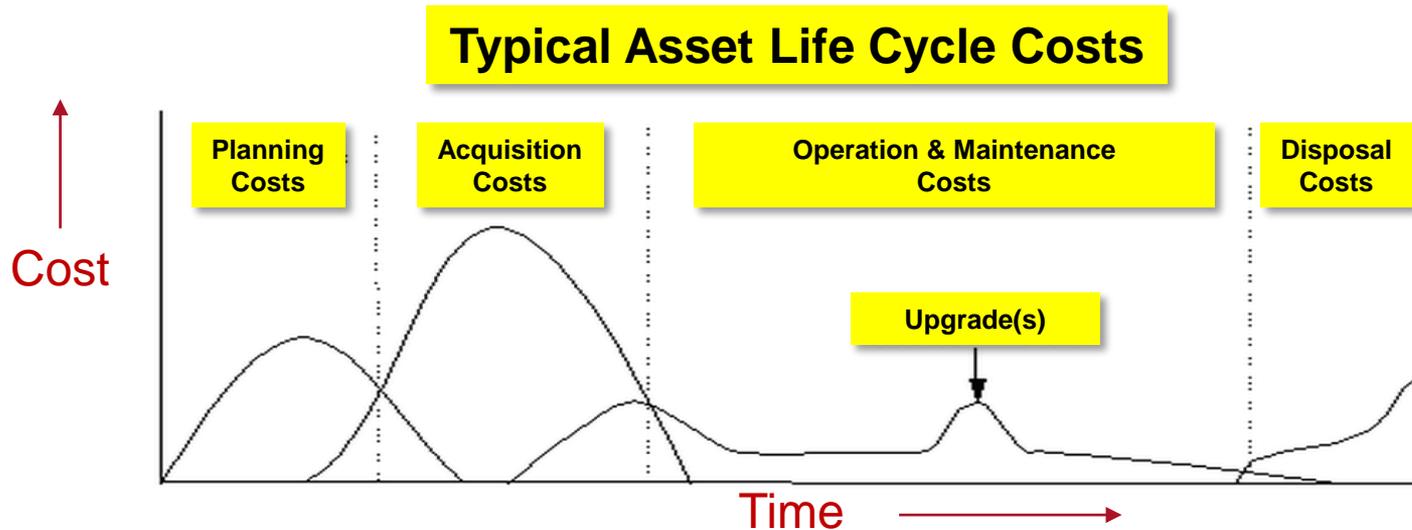
Financial Year	Price* (USD \$)
2012–13	23.00
2014	24.15
1 July 2014 onwards	Revoked

Source: Clean Energy Regulator - per tonne of emitted CO₂



■ Total Cost of Ownership - General Definition

Total Cost of Ownership is the total cost of acquisition and operating costs over the asset life cycle. A TCO analysis can be used to gauge the viability of any capital investment



Factors Affecting TCO

- When purchasing, or replacing a transmitter, Total Cost of Ownership is more important than just the purchase price alone
- Some of the items that must be considered:



Equipment acquisition cost (inc. taxes/duties/shipping, etc.)



Financing/Loan/Payment Terms (if applicable)



Building space requirements (own, lease, purchase)



Shipping to site, Installation and commissioning costs



Operational cost of the equipment, including:



AC power costs



Personnel training



Routine maintenance costs / site visits



Repair costs



Upgrades

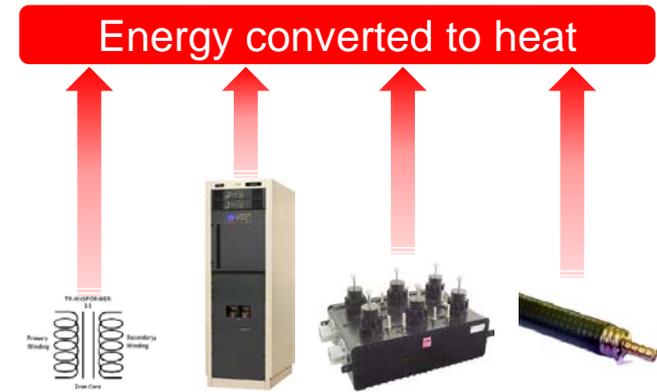


Warranty and other factors



TCO versus Efficiency

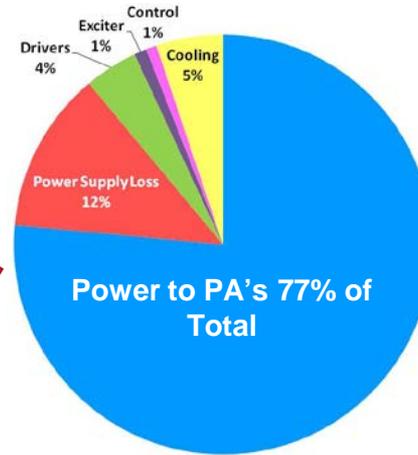
- **TCO is what is really important to a transmission operator:**
 - It's the total cost to own and operate the transmitter system over time
 - Includes initial equipment cost and delivery
 - Includes the installation/commissioning cost
 - Includes routine and unscheduled maintenance costs
 - Repair/replacement and other operational costs
- **AC power consumed by the transmitter is important**
 - However, other factors also affect the system efficiency:
 - AC transformers and voltage regulators
 - Heat load to the room (HVAC costs)
 - RF system losses (often significant)
 - RF feeder losses
 - ex: Ch30, 2,000ft, 6-1/8" rigid line, energy loss = 38%
 - Non-optimal antenna pattern (throwing RF energy away)



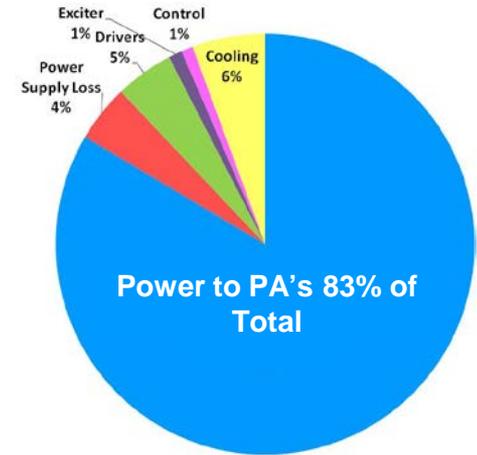
Every Part of The Transmitter Matters

Effect of power supply efficiency on overall system efficiency

	Tx with older PS	Tx with new High Eff. PS
RF Power Output (kW)	5.0	5.0
Power Amplifier Efficiency	45%	45%
DC Power to PA's	11.11	11.11
Power Supply Efficiency	86%	96%
AC Power to PA's	12.92	11.57
Power Supply Loss	1.81	0.46
Drivers	0.6	0.6
Exciter	0.14	0.14
Control	0.12	0.12
Cooling	0.75	0.75
Total AC Input (kW)	14.53	13.18
Overall Tx Efficiency	34%	38%



Distribution of Power Usage with Older Technology Power Supplies



Distribution of Power Usage with High Efficiency Power Supplies



Power Supplies make 4% difference



- At GatesAir we are constantly updating designs to improve efficiency and lower TCO:
 - Higher Efficiency RF Devices & PA Module design
 - Higher Efficiency Power Supplies
 - Optimized Energy Efficient Cooling Systems
 - Broadband, future-proof designs
 - Improved up-time and reduced maintenance costs
 - Modular designs with Faster MTTR (Mean Time To Repair)
 - Higher Power Density for reduced floor space
 - User-friendly designs, easier to understand and operate



PowerSmart® is the on-going GatesAir design initiative to create the most efficient transmitter designs and products. GatesAir leverages the most sophisticated tools to develop cost, energy, and space efficient solutions.

Television



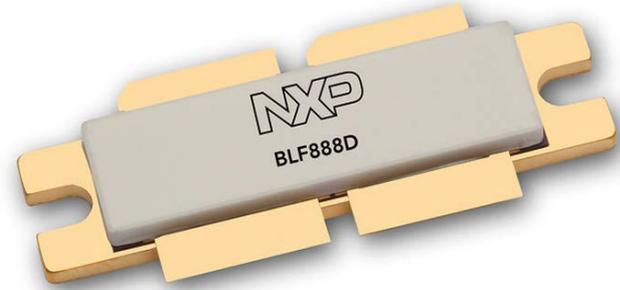
The Maxiva™ family of UHF transmitters led this initiative with the first 50V LDMOS device-driven transmitter in the industry setting a new benchmark for power density and efficiency.

Radio

The Flexiva™ family of FM transmitters set new benchmarks with operating efficiencies of up to 72%, the first FM design to use 50V LDMOS devices, and the smallest footprint at 10kW and higher power levels.



- New 50V LDMOS devices introduced that dramatically increase power density and efficiency
- Broadband high efficiency TV devices for VHF Band III and for UHF
- High Gain (> 15dB)
- Power 600W (CW) / 130 W TV average power
- Rugged
- Very High MTBF



BLF888D Features and benefits (from data sheet):

- High efficiency
- High power gain
- Excellent ruggedness (VSWR > 40 : 1 through all phases)
- Excellent thermal stability
- Integrated ESD protection
- One Doherty design covers the full bandwidth from 470 MHz to 860 MHz
- Internal input matching for ease of use

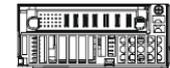
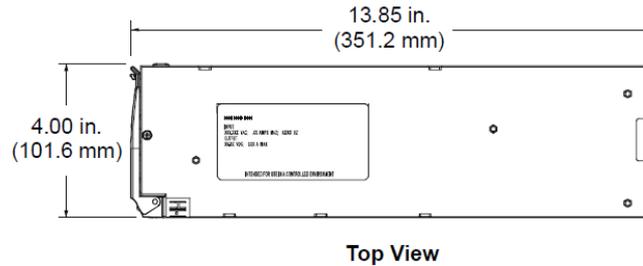


Power Supply Technology

- Improvements in Power density/weight
- Very high conversion efficiency
 - 96.3% versus 84% only 6 years ago
- With 48-50V DC requirement, can leverage the Telecomm industry:
 - Very high MTBF (900,000hrs)
 - High volume part
 - Widely available Worldwide
- Versatile
 - Use same part in FM and TV products



2,725 Watt high-efficiency power supply (weight 2kg)



Rear View



Front View

Reliability (calculated)	900,000	Hours	At ambient of 25°C at full load per Telcordia SR-332, issue 2, Reliability Prediction for Electronic Equipment, Method I Case III.
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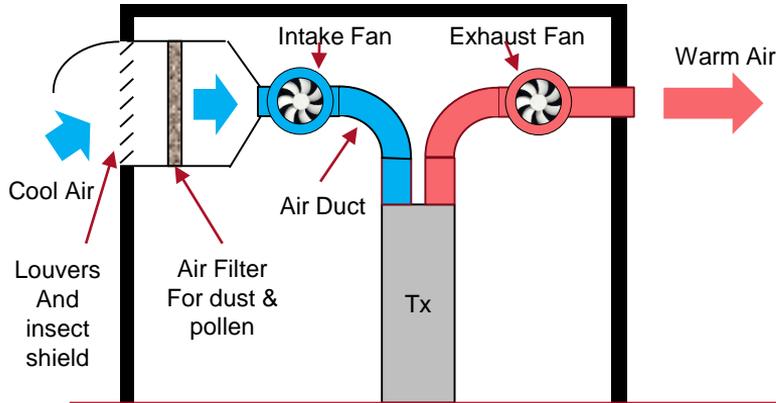


Optimized Cooling Systems

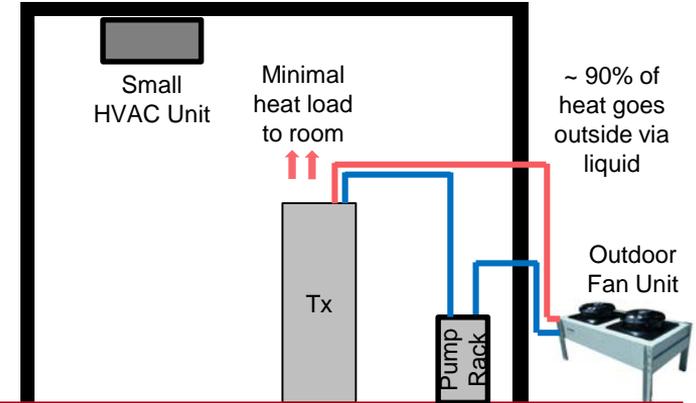
- Three common cooling methods for broadcast transmitters
 1. Air-cooled using outside air
 2. Air-cooled using inside air and Air-Conditioning
 3. Liquid cooling
- Each of these has some advantages and disadvantages



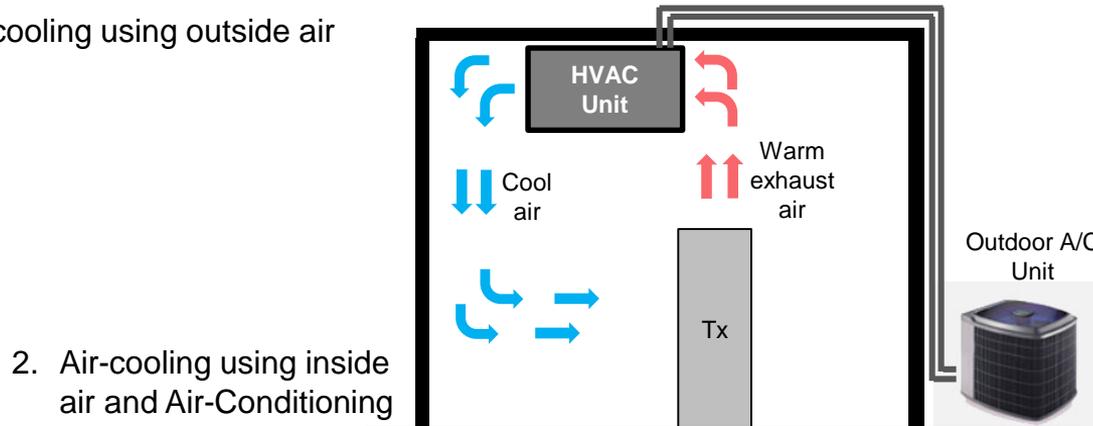
Three Ways to Cool the Transmitter



1. Air-cooling using outside air



3. Liquid-cooling



2. Air-cooling using inside air and Air-Conditioning

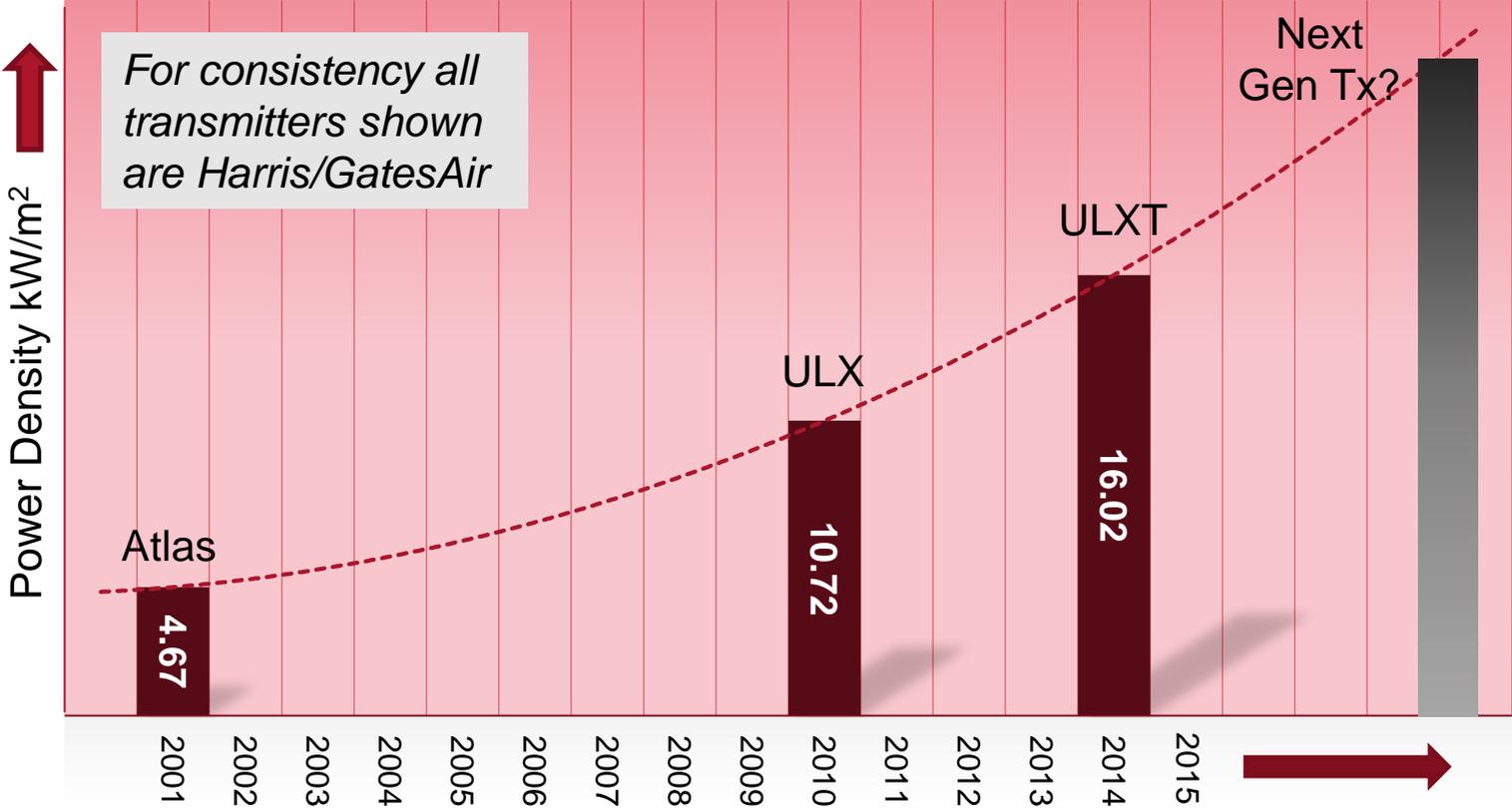


Cooling Comparison

Item	Air-Cooled (outside air)	Air-Cooled (HVAC)	Liquid Cooled
Energy cost	Low	High	Low
Maintenance	Very High	Medium	Low
Installation cost	High	Medium	Medium/Low
Site visits	Frequent	Infrequent	Infrequent
Humidity control	None	Excellent	Excellent
Dust & dirt	Filter dependent	Excellent	Excellent
Reliability	Medium	Medium	Medium/Excellent
TCO Rank	3	2	1



Space Savings Trend (TV liquid-cooled Tx)



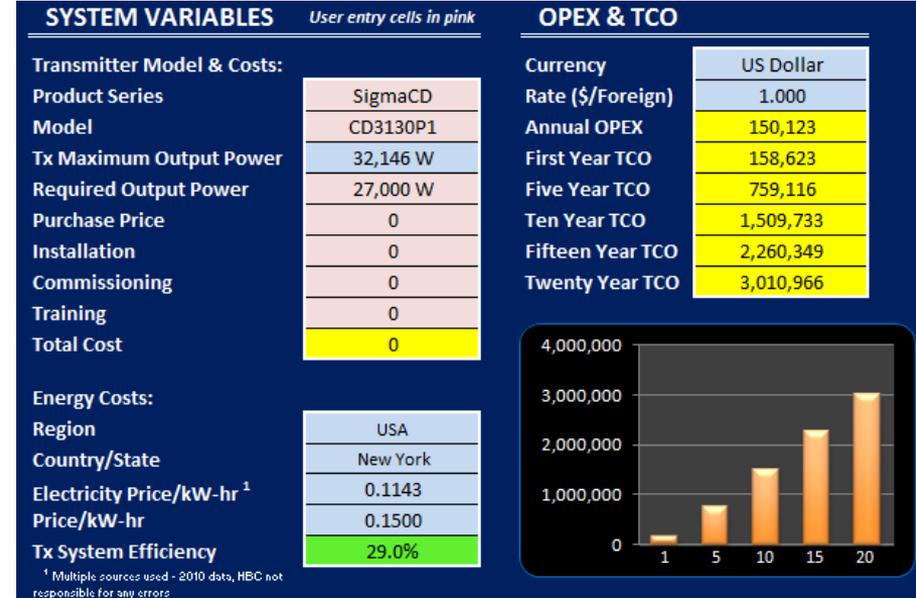
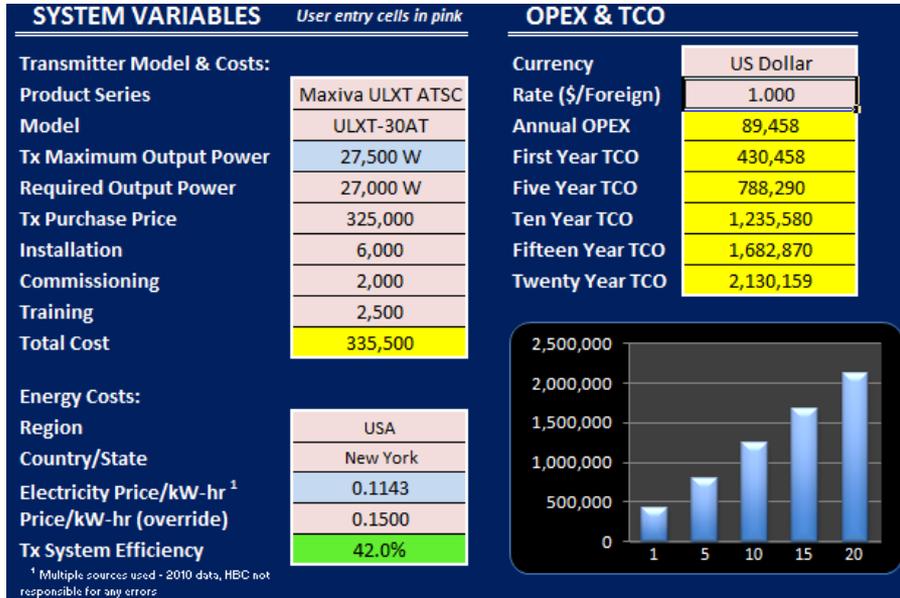
TCO Example: UHF-TV Replace IOT with New Tx

■ New Transmitter

- At 27.5kW ATSC
- Power Cost – 15.0 c/kW-hr
- 10 year TCO (inc. purchase price) = \$1.24M

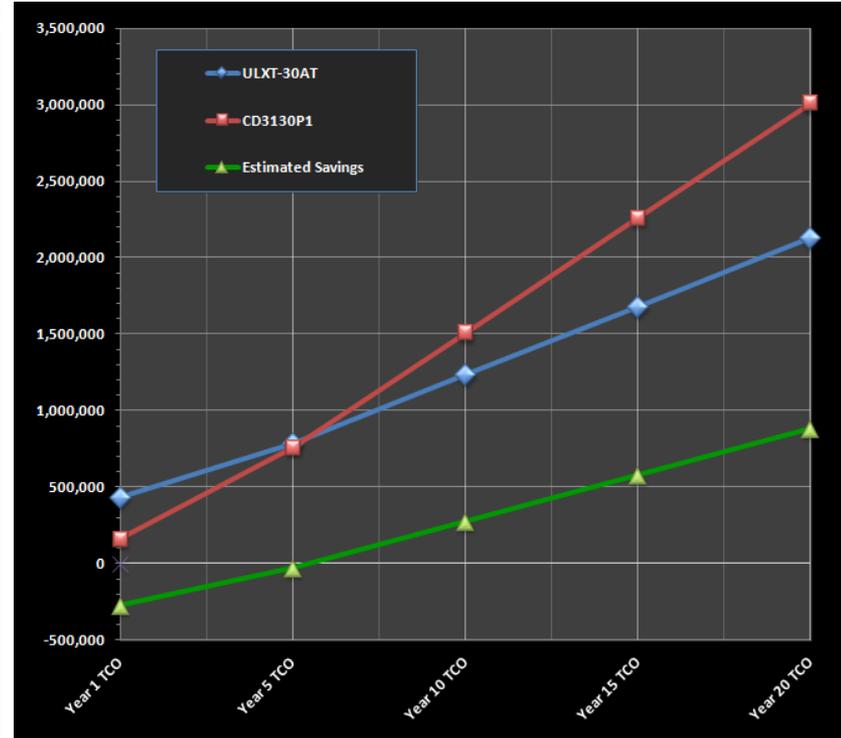
■ Old Transmitter (IOT)

- At 27.5kW ATSC
- Power Cost – 15.0 c/kW-hr
- 10 year TCO = \$1.59M



TCO Example: UHF-TV Replace IOT with New Tx

Transmitter Models:	ULXT-30AT	CD3130P1	Estimated Savings
Product Series	Maxiva ULXT ATSC	SigmaCD	
Model	ULXT-30AT	CD3130P1	
Tx Maximum Output Power	27,500 W	32,146 W	
Required Output Power	27,000 W	27,000 W	
Purchase Price	325,000	0	-325,000
Installation	6,000	0	-6,000
Commissioning	2,000	0	-2,000
Training	2,500	0	-2,500
Total Cost	335,500	0	-335,500
Energy Costs:			
Region	USA	USA	
Country/State	New York	New York	
Price/kWh	\$0.150	\$0.150	
Tx System Efficiency	42.0%	29.0%	
OPEX:	ULXT-30AT	CD3130P1	Estimated Savings
Annual OPEX	89,458	150,123	60,665
Year 1 TCO	430,458	158,623	-271,835
Year 5 TCO	788,290	759,116	-29,173
Year 10 TCO	1,235,580	1,509,733	274,153
Year 15 TCO	1,682,870	2,260,349	577,480
Year 20 TCO	2,130,159	3,010,966	880,806
Breakeven Period			5.4 Years



Breakeven in 5.4 years
(less than 5 years if tubes factored in)





NEW FLX Liquid Cooled FM Transmitter

- FLX10K
 - 12 kW Analog at 72% AC-RF Efficiency
 - 9.7 kW Analog, FM+HD @ -14dBc – 60% AC-RF Efficiency
 - 7.7 kW Analog, FM+HD @ -10dBc – 55% AC-RF Efficiency
- **Power Block Scalable 5kW – 80kw**

**Available in Digital-Ready Analog
Or Fully Digital**



FLX10K 16RU Cabinet

- 12 kW average power
- 17kW peak power
- 7 - 50 Volt, 2.75 kW power supplies
 - 96% AC-DC Efficiency
- 14 - **New** 970 Watt PA pallets
- 7 - 1940 Watt PA modules
 - 82% DC-RF PA efficiency
- Dual Exciter and IPA – failover switching





- 88% overall heat dissipation to liquid transfer efficiency
- Internal or external redundant pump modules
- Two 10kW transmitters with dual exciters, in a single rack
- 20kW with dual exciters in a single rack
- 40kW in four racks

= Lowest Total Cost of Ownership!



Transmitter TCO Comparison (GatesAir / GatesAir)



Transmitter Models:

Product Series

Model

Tx Maximum Output Power

Required Output Power

Purchase Price

Installation

Commissioning

Training

Total Cost

FLX T 10K @-10

FLXT
FLX T 10K @-10
7,700 W
7,600 W
105,299
23,093
0
0
128,392

FAX 10K @ -10

Flexiva FM HD Transmitter
FAX 10K @ -10
7,700 W
7,600 W
\$85,000.000
23,093
0
0
108,093

Estimated Savings

20,299
0
0
0
20,299

Energy Costs:

Region

Country/State

Price/kWh

Tx System Efficiency

USA
Florida
\$0.120
53.7%

USA
Florida
\$0.120
51.3%

OPEX:

Annual OPEX

Year 1 TCO

Year 5 TCO

Year 10 TCO

Year 15 TCO

Year 20 TCO

FLX T 10K @-10
18,679
148,571
223,289
316,687
410,084
503,482

FAX 10K @ -10
24,630
137,223
235,745
358,897
482,048
605,200

Estimated Savings
5,951
-11,348
12,455
42,210
71,964
101,718

Breakeven Period

3.0 Years

Notes & assumptions:

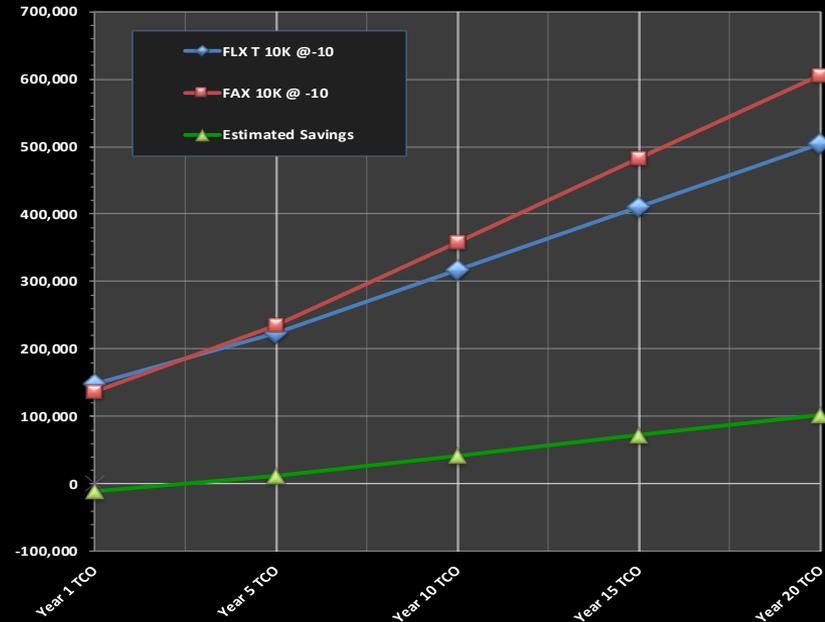
Operating output power must be less than or equal to the max. Tx power is pre-filter

No real estate purchase or rental costs are included

Annual tx maintenance of \$2,400 (unless edited in cells V10, V11)

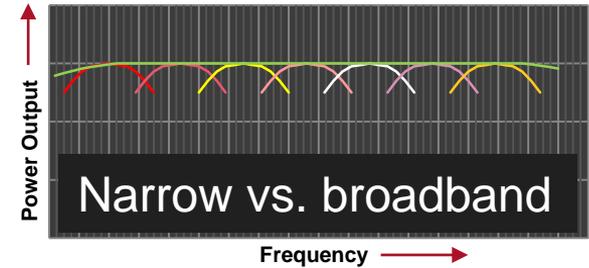
HVAC acquisition cost of \$1,150/ton, installation cost of \$2,500 (unless edited in cell V7)

Tx heat load to room is cooled by HVAC system. Default SEER = 12 (unless edited in cells V6, V10)



Summary – Things to Consider

- Broadband versus Banded TV Transmitter
 - Are you ready for Re-pack?
- Potential utility company rebates?
- Obsolescence and spare parts availability?
- High-voltage vs. Low-voltage (safety)
- Tx complexity and serviceability
- Modularity and On-air reliability
- Size, weight and ease of replacing modules
- Service & support from manufacturer



VS.



VS.

