

SCTE CABLE-TEC
EXPO'13
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BROWNOUTS IN THE BROWNFIELDS?

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(Formerly) Fellow of the Technical Staff

ARRIS

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Agenda

What's Happening Now

- Fiber Deep...Deeper...Deepest?
- FTTP Business Services
- Plant-Based Wireless Access Points

What's Happening Next

- HFC Spectrum Expansion
- Distributed Architectures

Power Consumption Growth Accounting

- ACME CableCo – A Service Evolution Timeline

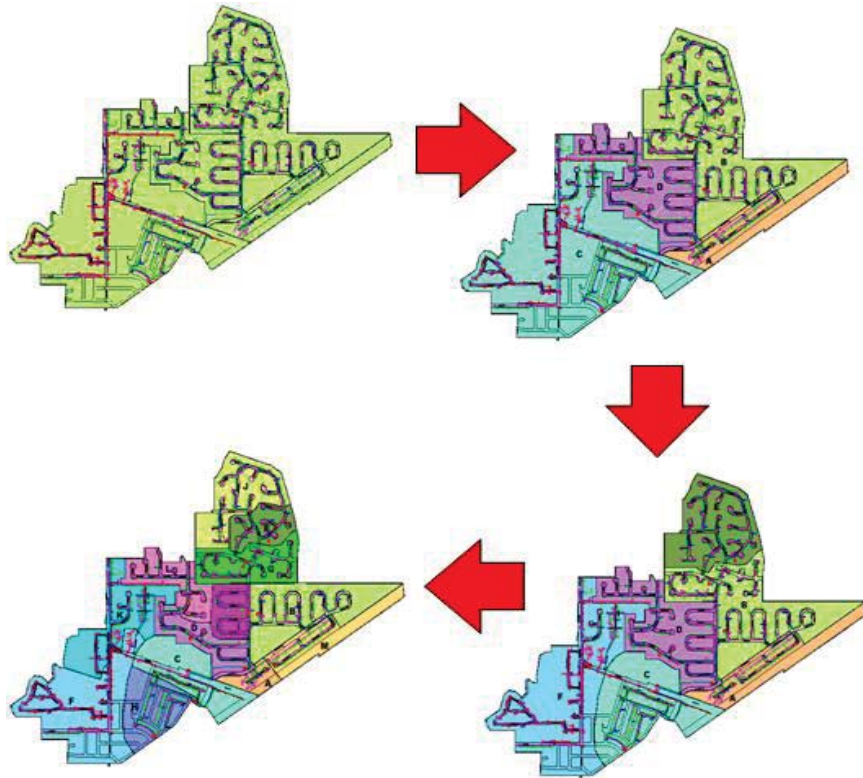
Architecture and Technology Efficiency Opportunities

- In-the-Box
- Out-of-the-Box

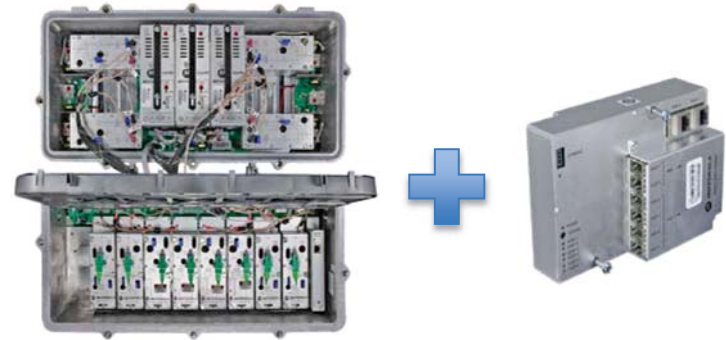
Summary



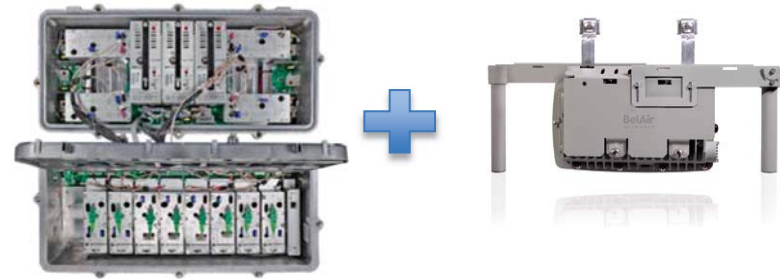
What's Happening Now



Fiber Deeper



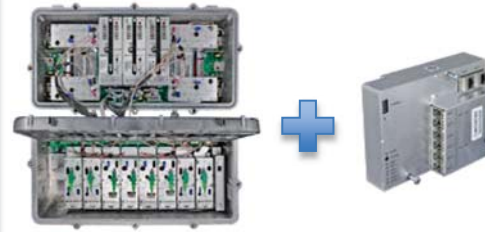
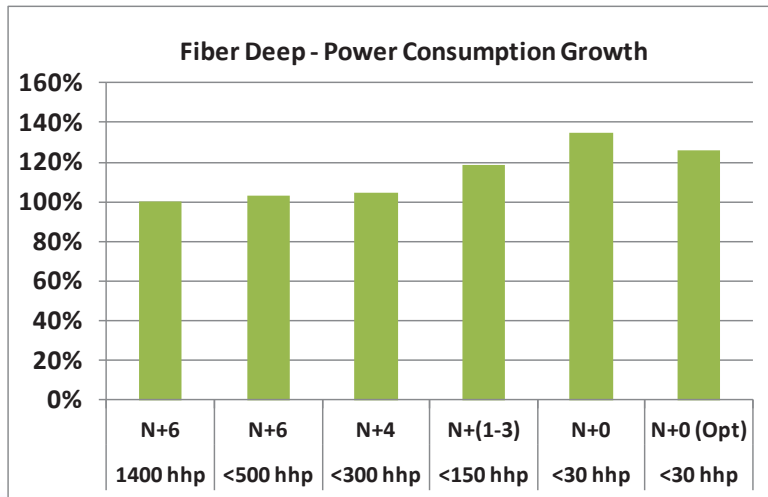
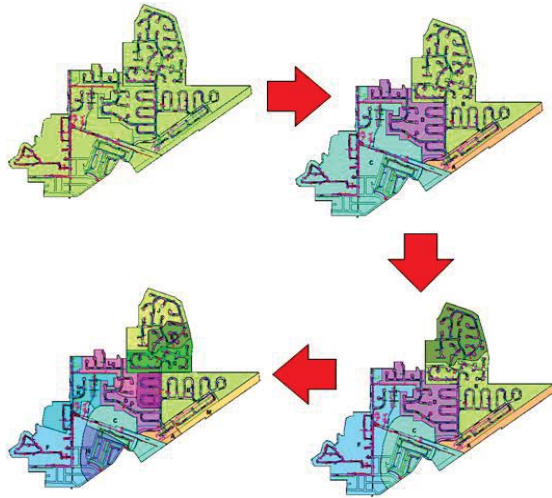
Fiber-Based Biz Services



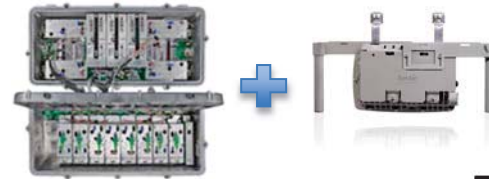
HFC WiFi™ APs



Quantifiable “Knowns”



	Single SW 2 WAN/4 LAN	Two SW 4 WAN/8 LAN
1x1	+21%	+42%
2x2	+17%	+34%
4x4	+12%	



**WiFi+Picocell ~
Medium Size Node**

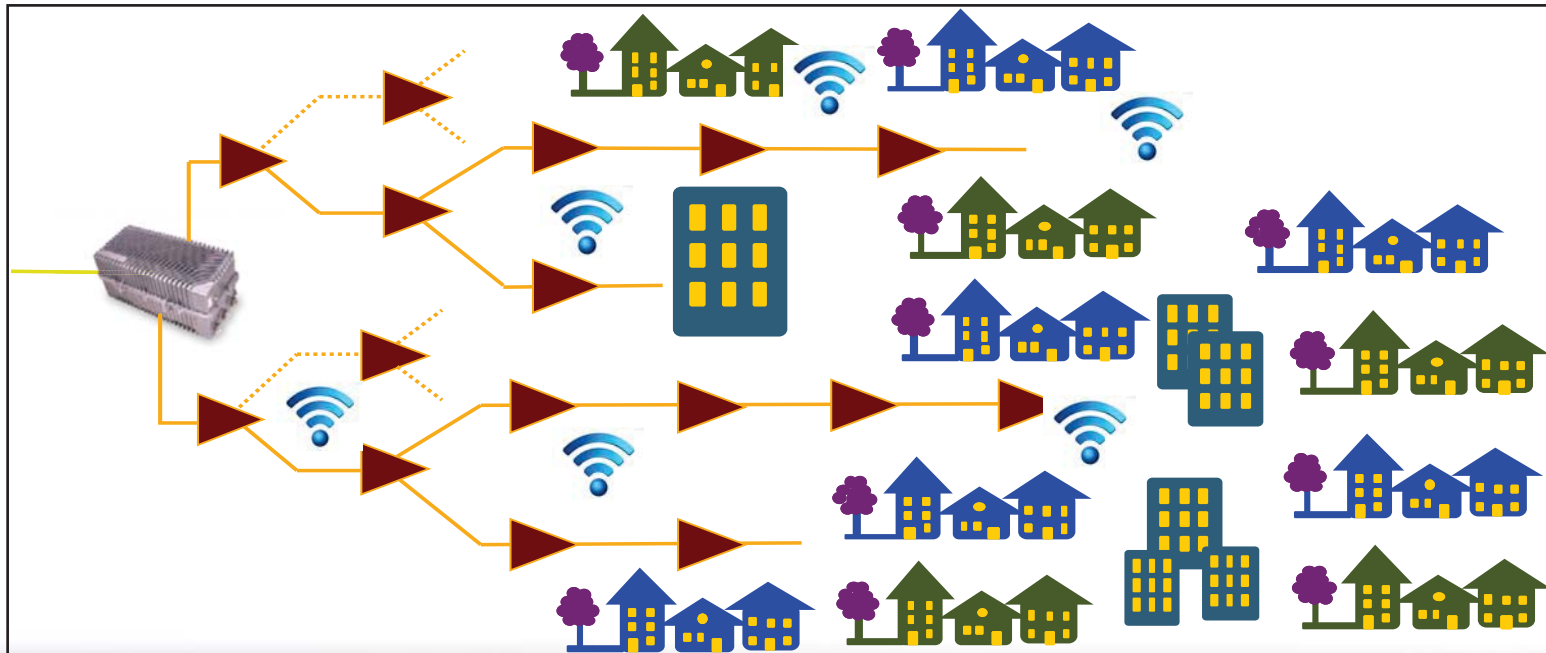
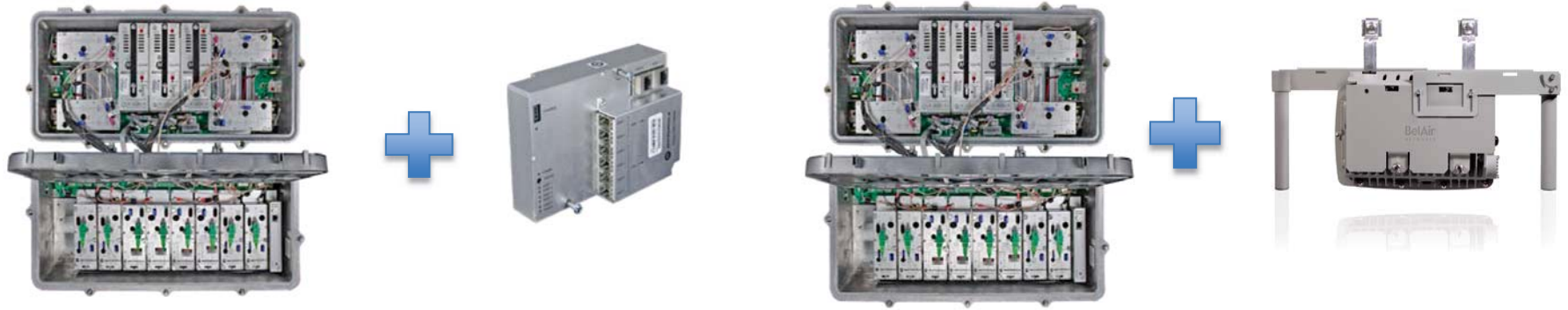
	Wifi	WiFi + 3G Picocell	WiFi + 4G Picocell
1x1	+83%	+90%	+118%
2x2	+56%	+73%	+96%
4x4	+40%	+52%	+69%



WiFi Only ~ Medium Size Amplifier (Bridger)

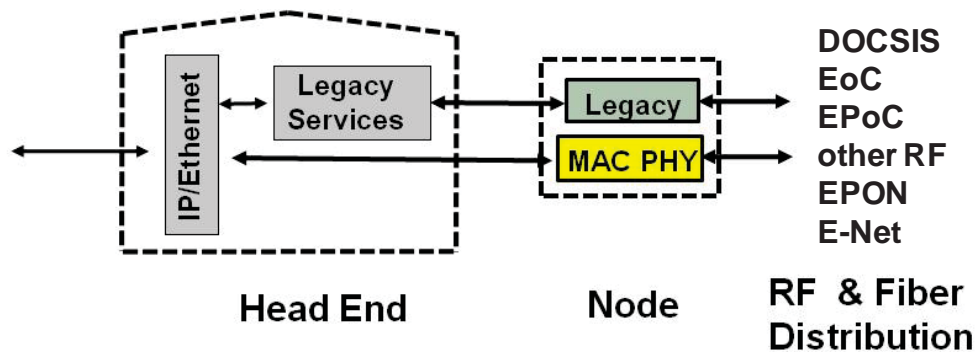
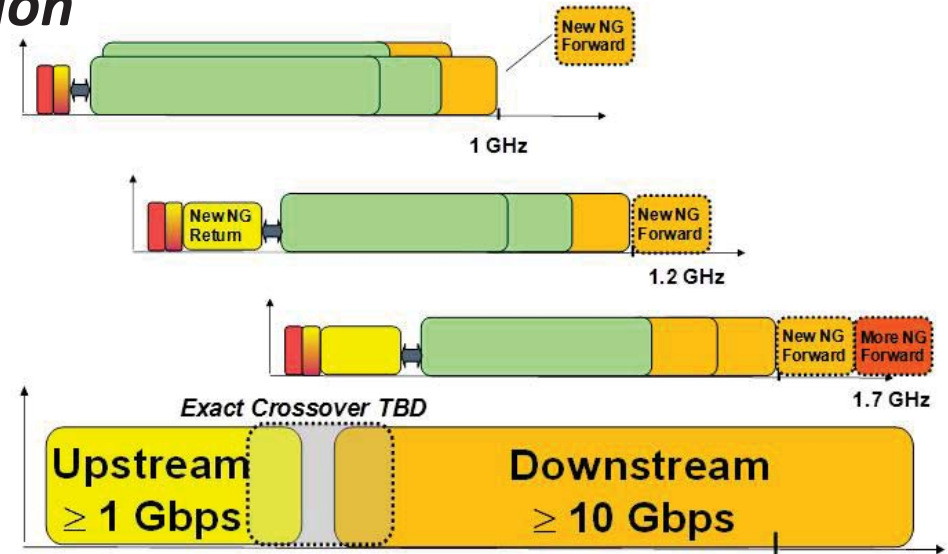
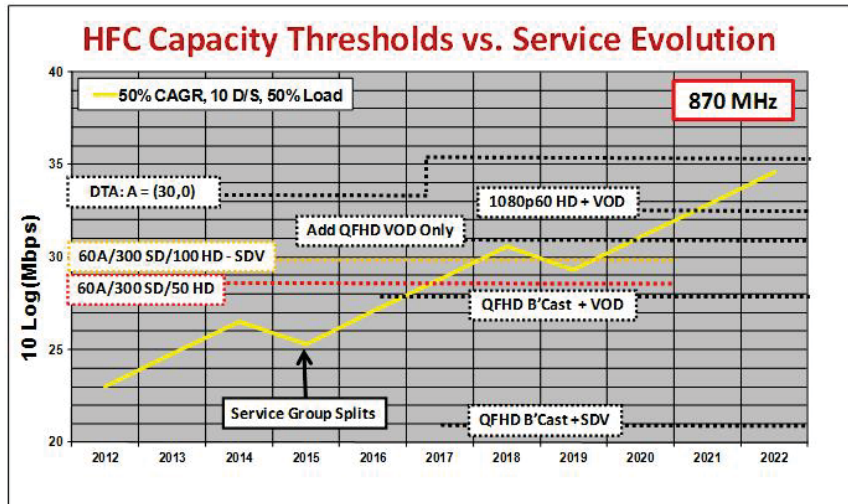
	Wifi	WiFi + 3G Picocell	WiFi + 4G Picocell
	+100%	+130%	+170%

Service Area Effect? Sizing & Penetration



What's Happening Next

Persistent CAGR and D3.1 Objectives are Driving RF Spectrum Expansion



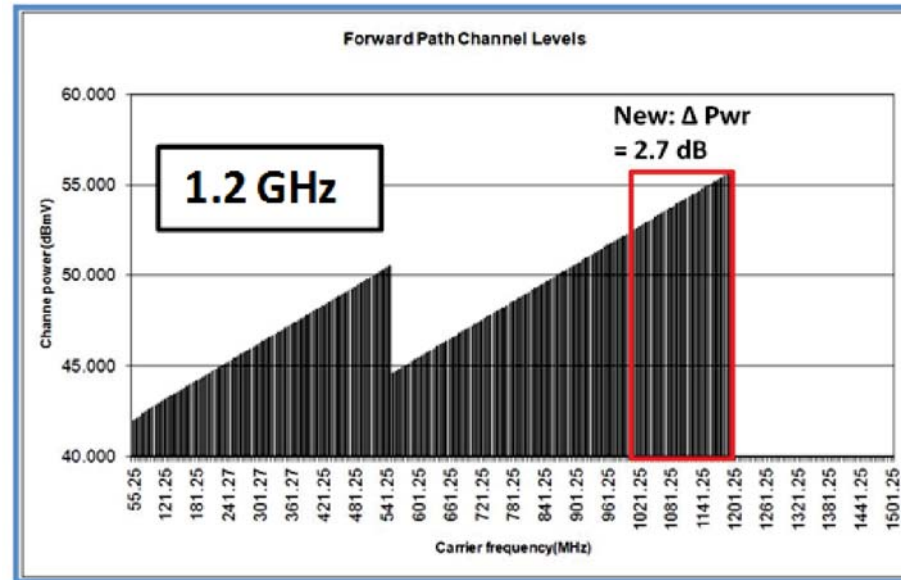
Remote PHY / Digital Optical Architectures



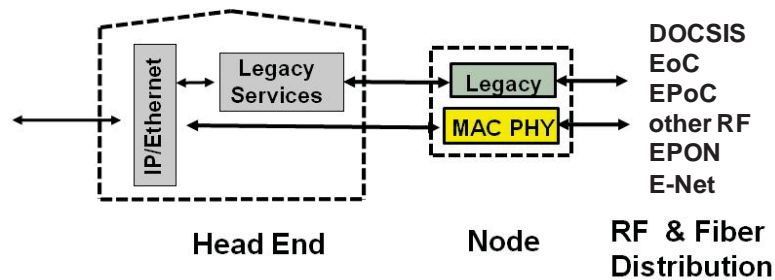
Projecting Unknowns

New Spectrum

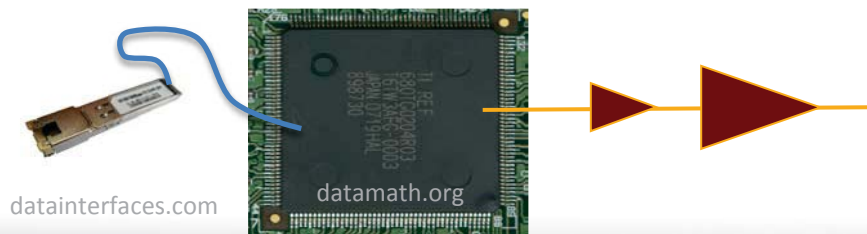
- *More BW = Increased RF load for Same System Levels*
- *Tilted Output Means the New Spectrum Disproportionately Effects RF Load*
- *Easily Quantified*



Digital Optical Architectures



- *Linear Optics to Digital*
- *Processing Moves into Node*
- *Can Reasonably Estimate*



ACME CableCo Roll-Out Plan

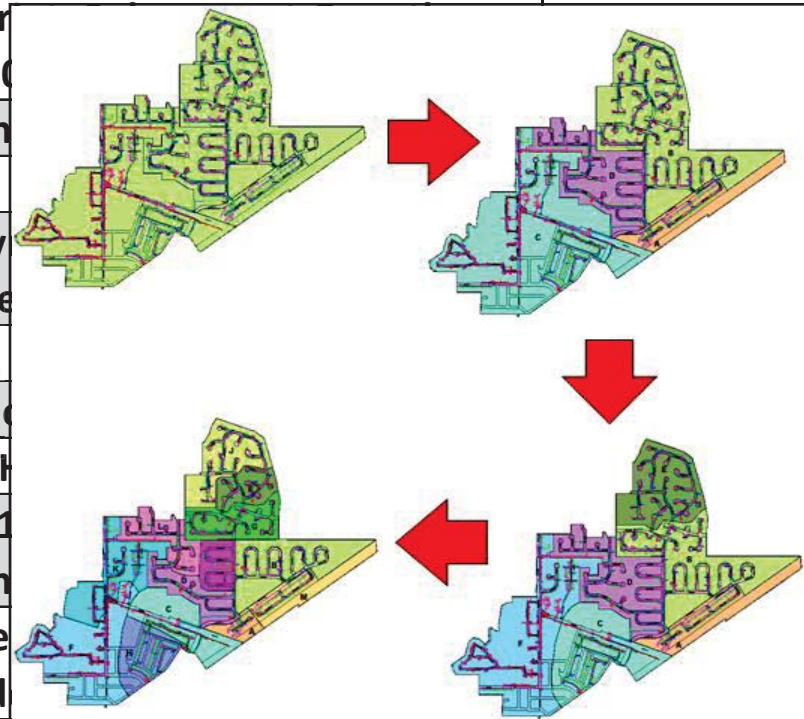
A Series

Roll-Out Plan

2013	Node Split ~1500 hhp Footprint (500 hpvn/N+6 to 300 hp/N+4)
2014	Introduce Ethernet Switched Biz Services Over HFC: Growth @ One New Customer/year
2015	Introduce Wifi @ 10% of footprint 25% / year for 6 yrs (40%)

This actual MSO system was used for the analysis

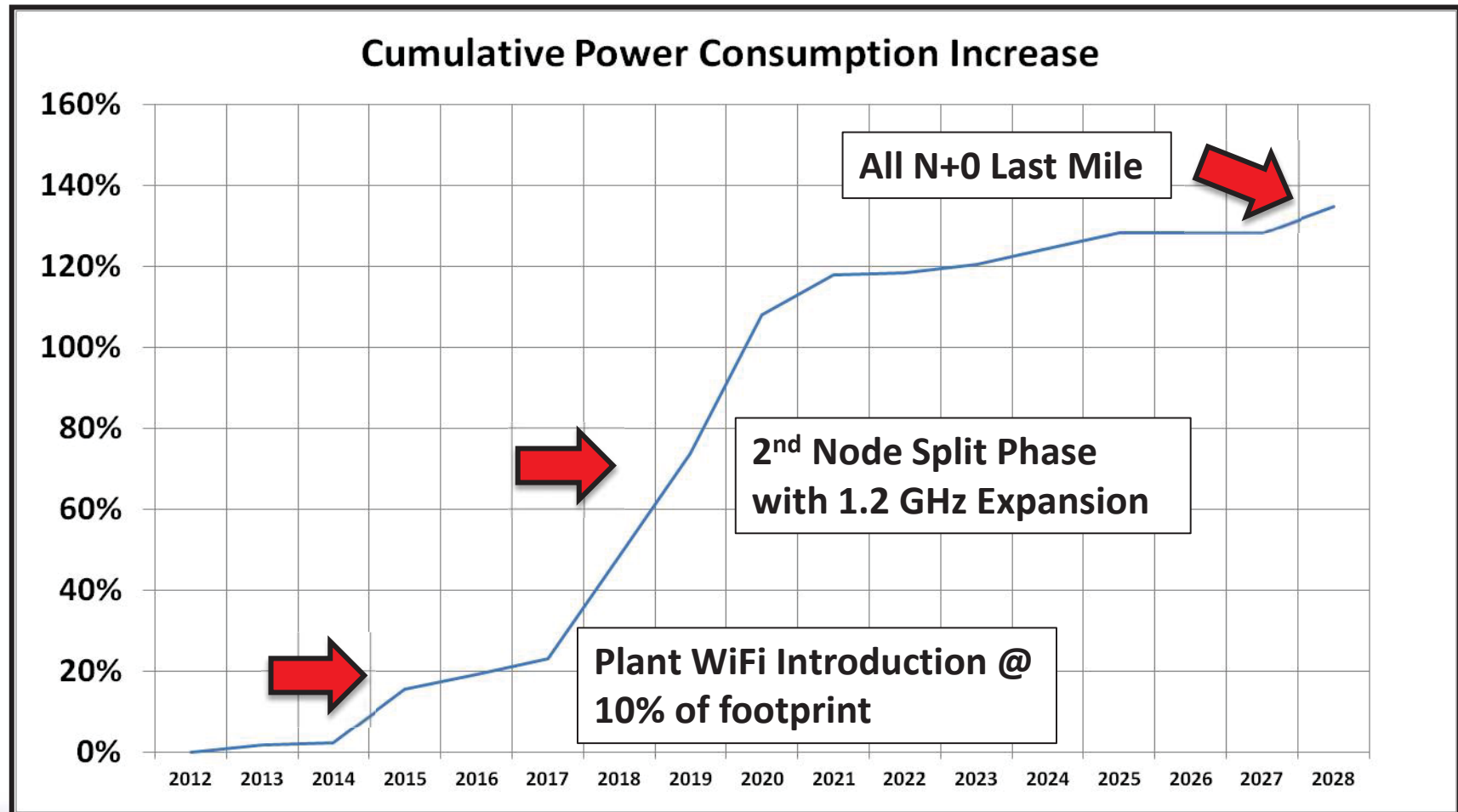
Model built on top of a detailed fiber deep analysis taken to N+0



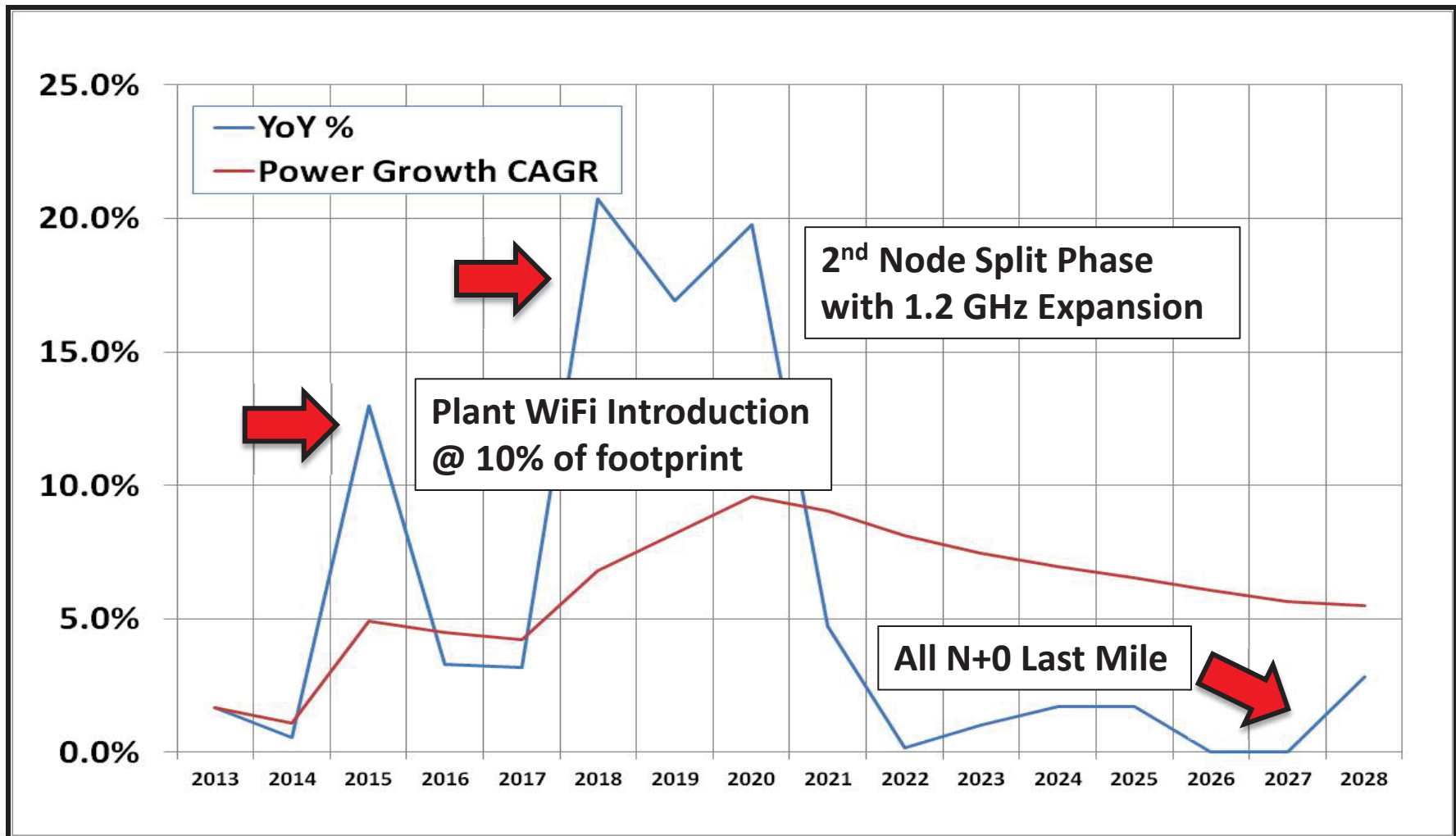
2023	Activate 1.2-1.5 GHz (Gbps Biz over CCAP EPON Sizing, 10% Node)
2024	Growth in 1.2-1.5 GHz
2025	70% of Footprint @ N+0
2026	
2027	Complete 1.2-1.5 GHz Build Out (Module per four businesses)
2028	Take Rest of Network to N+0 = NETWORK NIRVANA !

Cumulative Increase Over Serving Area Baseline

N+6, 500 hpvn

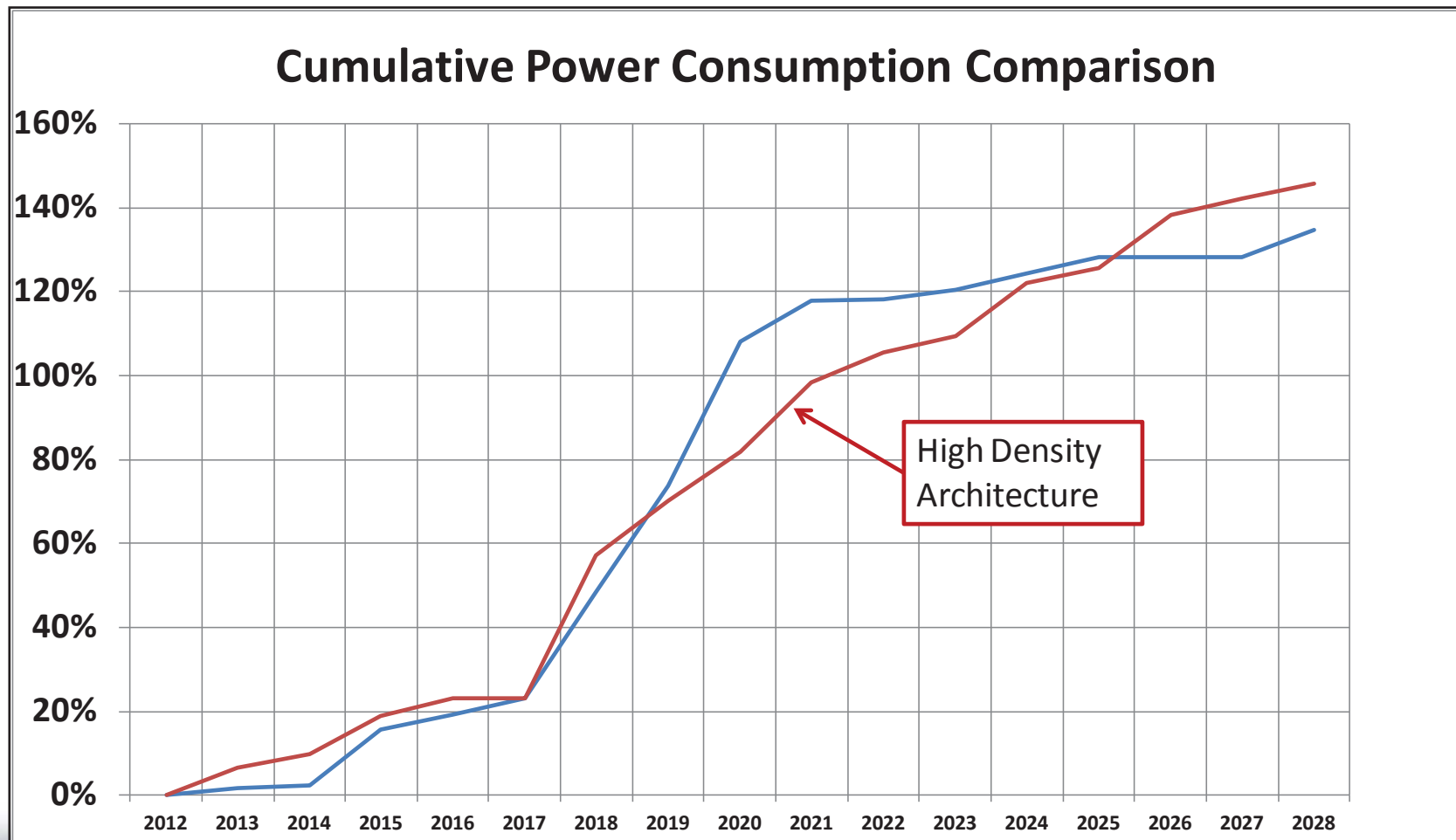


YoY % and Average Annual Rate of Power Consumption Increase

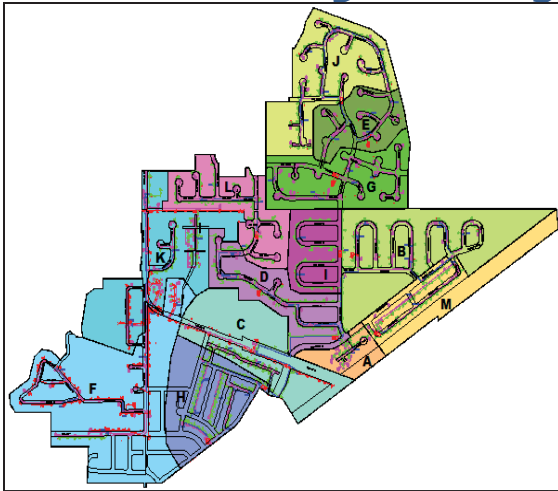


Comparison of Power Consumption Growth – Two Real Systems

Same Service and Network Evolution

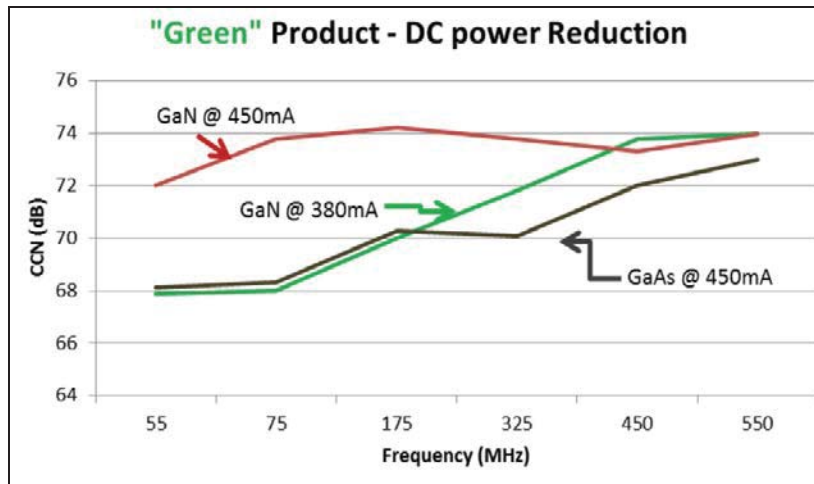
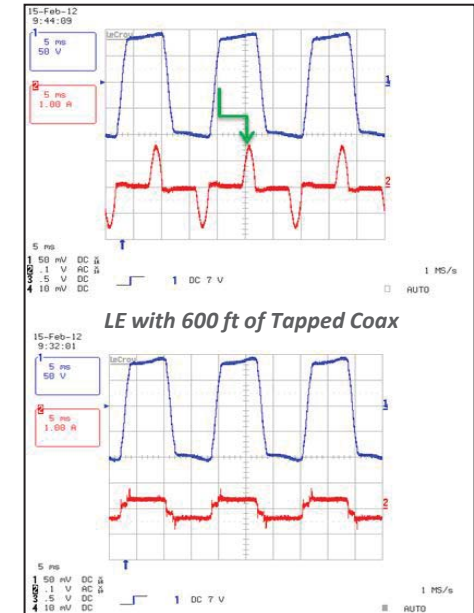


Architecture and Technology Efficiency Adjustments



FTLA

- 2021-2028 Evolution
- Amp-to-Node Conversion
- Optimization of locations (partial replumb)



Gen-2 GaN RF

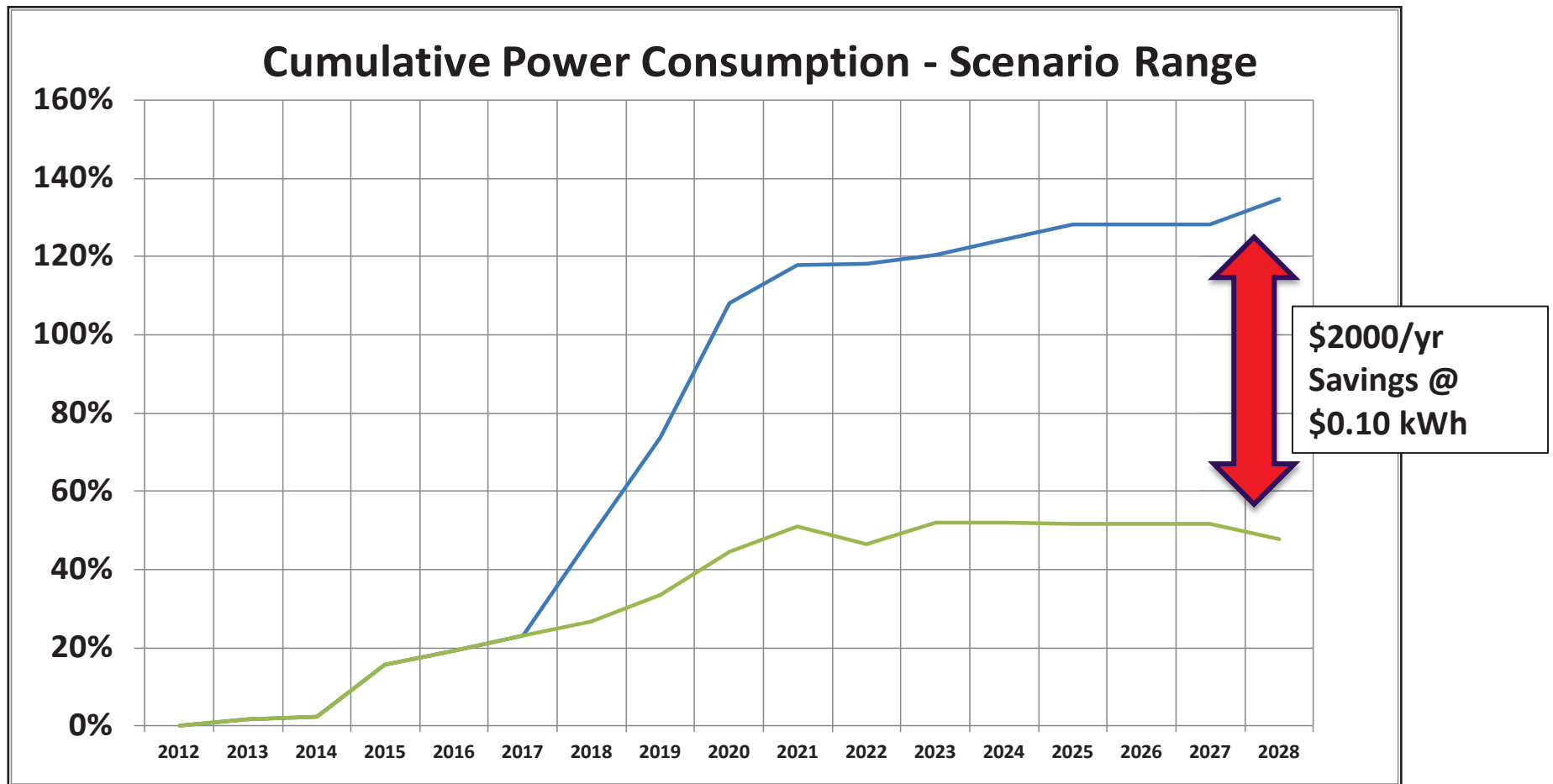
- Equivalent performance over wider BW
- Modest added power consumption for extended BW (1.2 GHz)

Available efficiencies powering plant actives

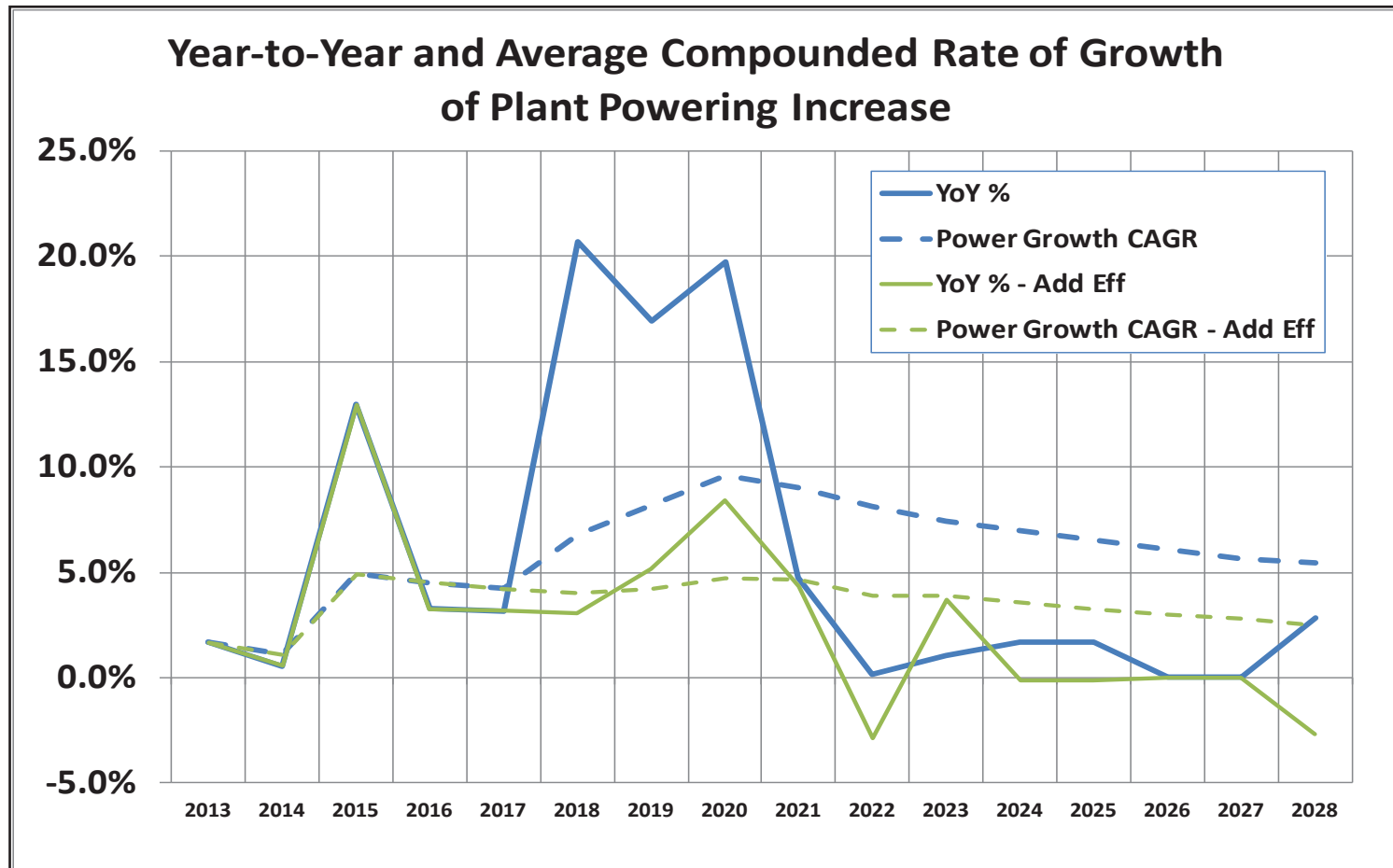
www.rfmd.com/cs/documents/CATV%20Hybrid%20Amplifier%20Module%20Past%20Present%20FutureWP.pdf



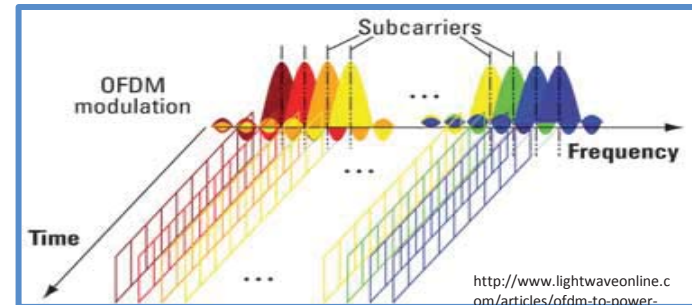
Architecture and Technology Efficiency Adjustments



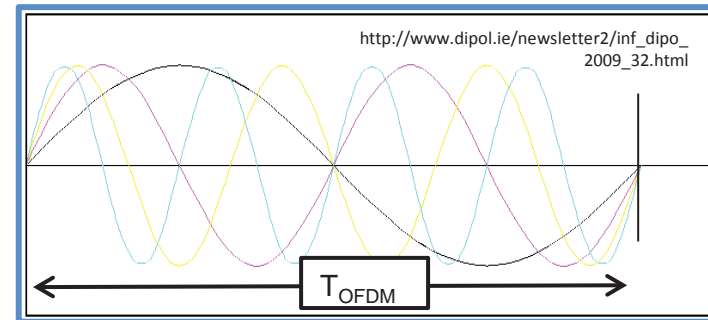
Architecture and Technology Efficiency Adjustments



What Else?



<http://www.lightwaveonline.com/articles/ofdm-to-power-high-bit-rates-in-next-gen-optical-access-networks.html>

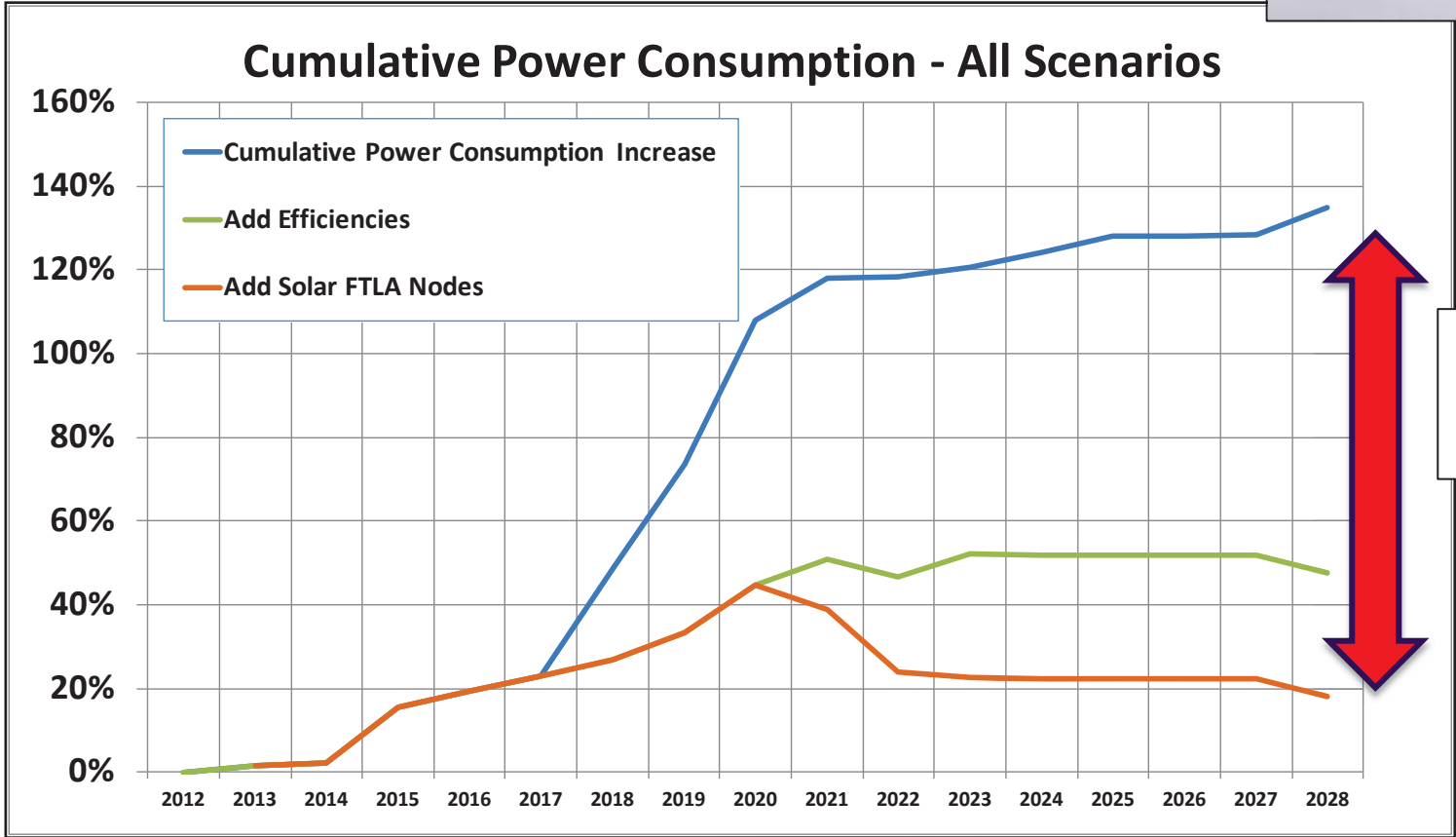


http://www.dipol.ie/newsletter2/inf_dipo_2009_32.html



What if ??....Solar Powering of Single-Port FTLA Nodes (2021-2028)

Approximately 40% of the Nodes



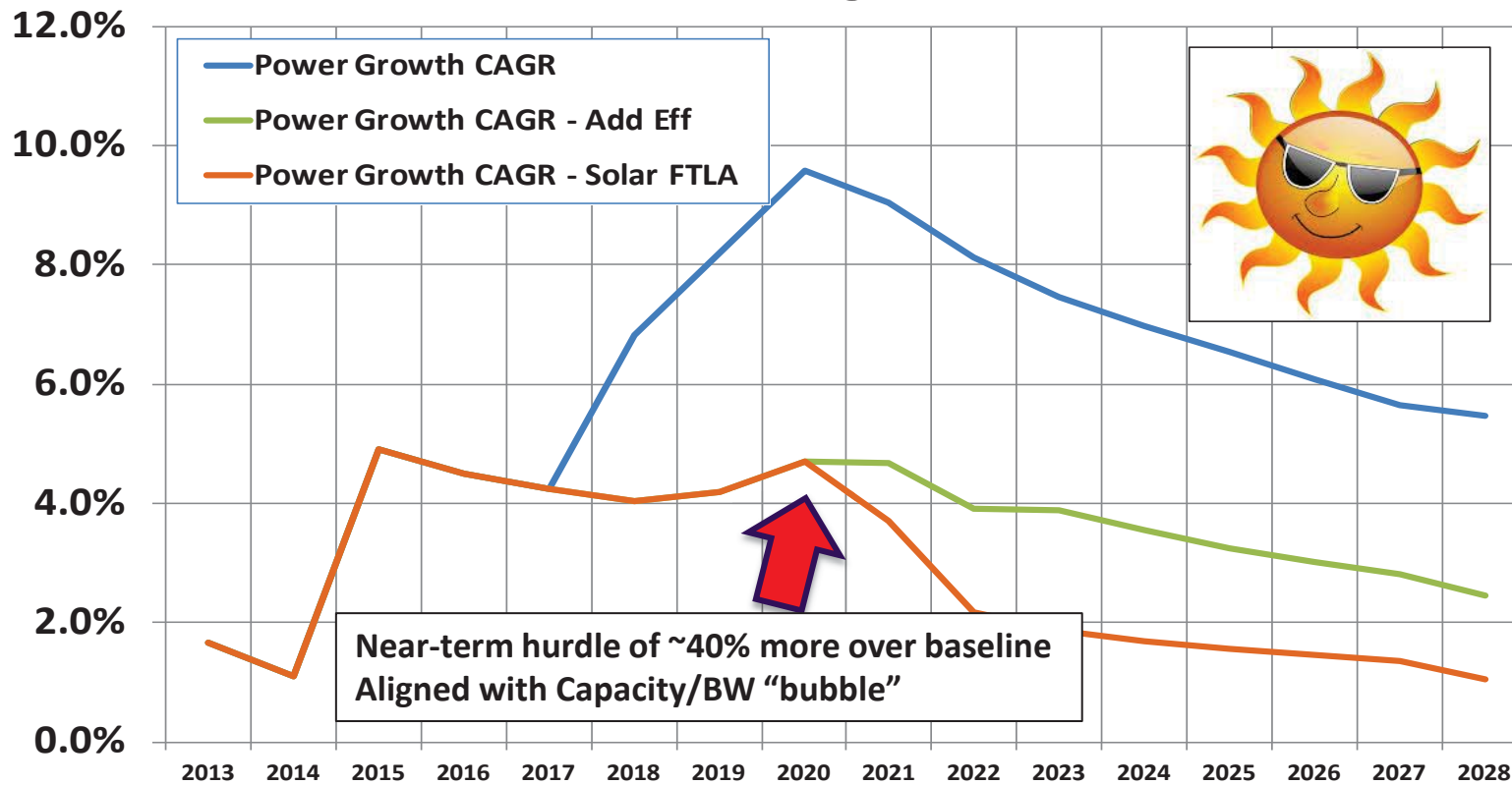
\$2700/yr Savings @ \$0.10 kWh



What if....Solar Powering of Single-Port FTLA Nodes (2021-2028)



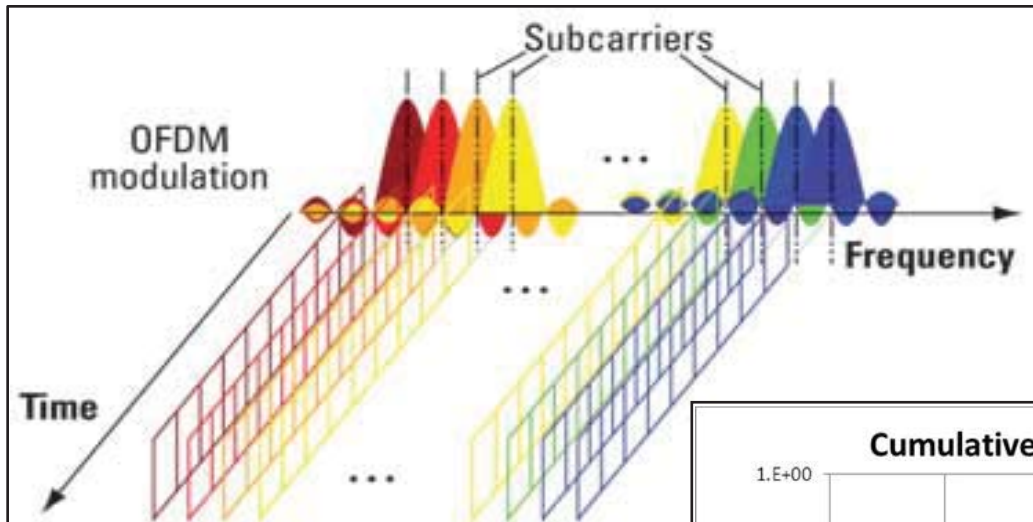
Year-to-Year and Average Compounded Rate of Growth of Plant Powering Increase



Near-term hurdle of ~40% more over baseline
Aligned with Capacity/BW "bubble"



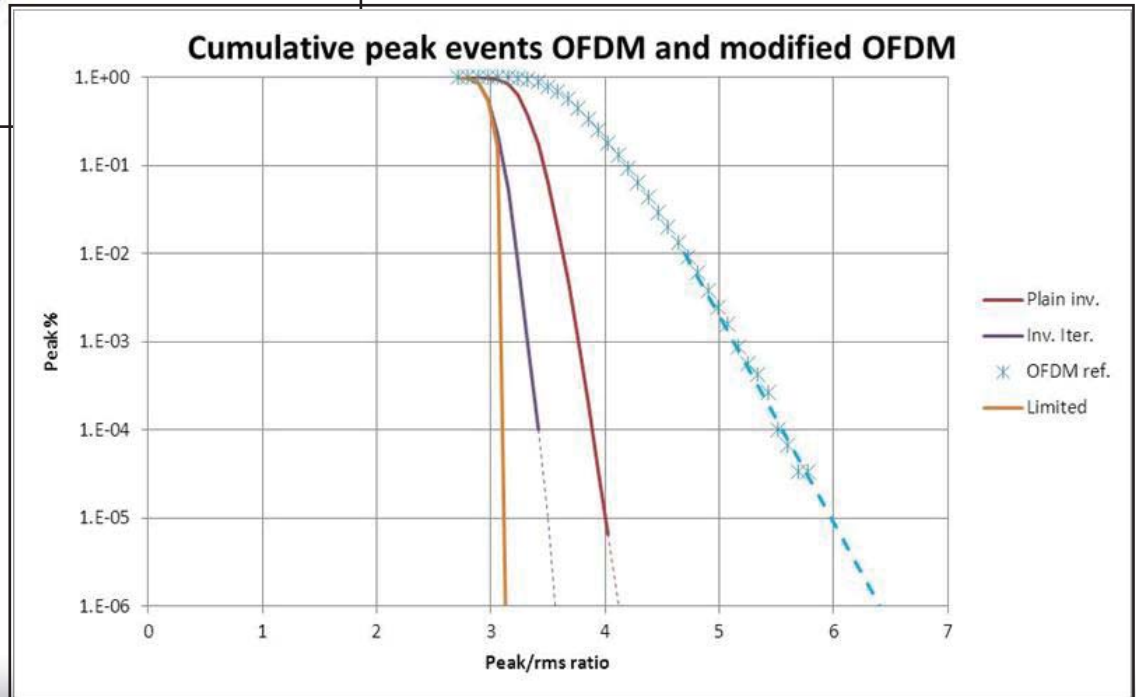
.....And One Last Trick !



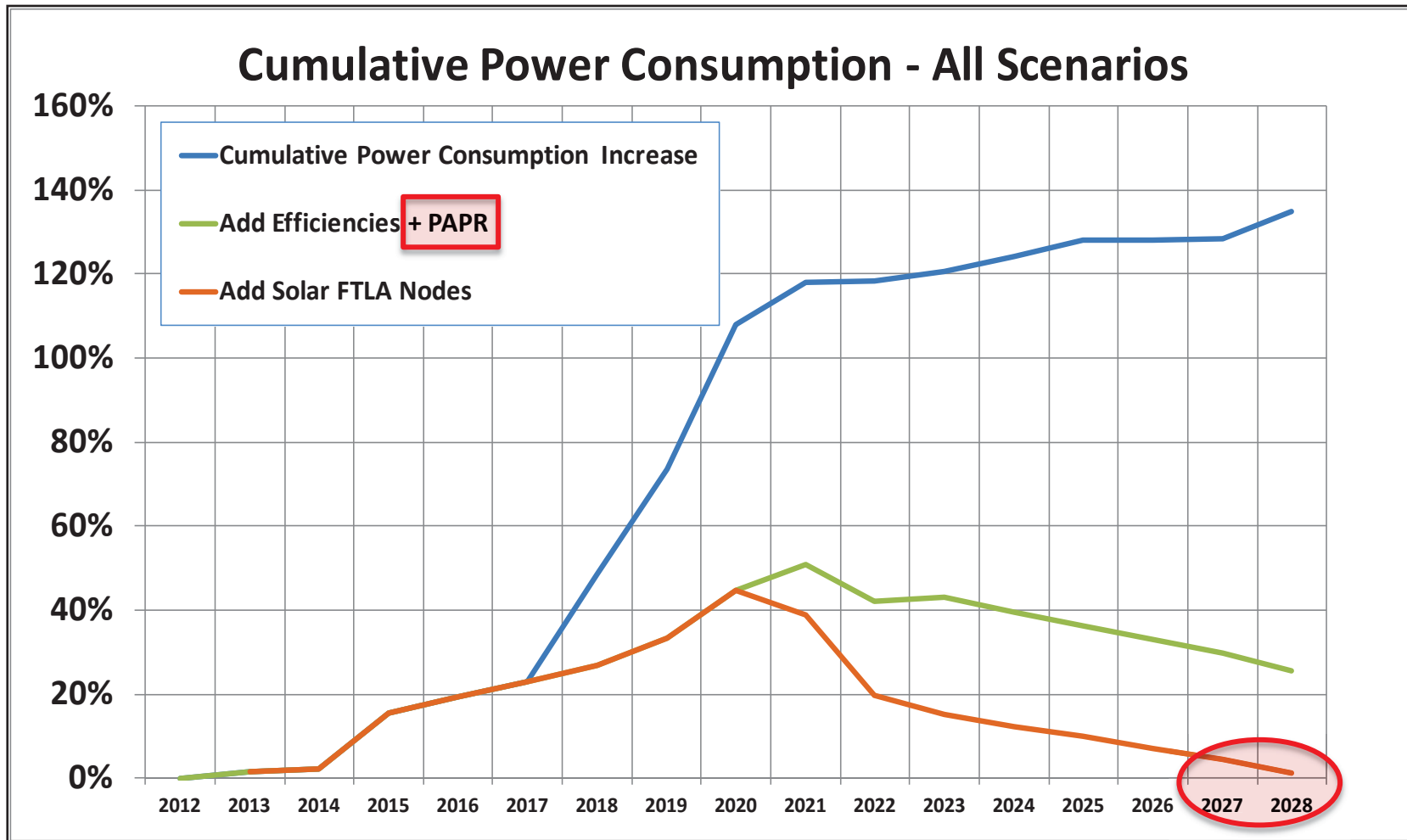
<http://www.lightwaveonline.com/articles/ofdm-to-power-high-bit-rates-in-next-gen-optical-access-networks.html>

- High PAR not suitable to some applications (cellular)
- Schemes devised to reduce OFDM PAR
- Lower PAR \Rightarrow Potential to reduce power consumption

- Cable is Evolving to OFDM in DOCSIS 3.1
- Native peak-to-average ratio (PAR) of OFDM is high (like noise)



Back to Day One on Power Draw!



Summary

New Services Require Plant Equipment That Increase Overall Power Consumption

Architecture Evolution Has Power Consumption Implications

Evolution Clashes With Reduced Opex & “Green” Initiatives

Implications Of Migration Scenarios Can Be Quantified

Efficiencies Of Technology And Architecture Bring Service Growth And Powering Implications Into Better Balance

Outside-The-Box Tools Could Eliminate Any Long Term Power Consumption Growth

Service Evo, Architecture Evo, And “Evo For Eco” Are Already Happening In HE And CPE– Plant Is Next



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