
# Impacts on Cable HFC Networks

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## Overview

- Bandwidth requirements
- Alternatives for meeting them
- HFC asset lives and percent goods

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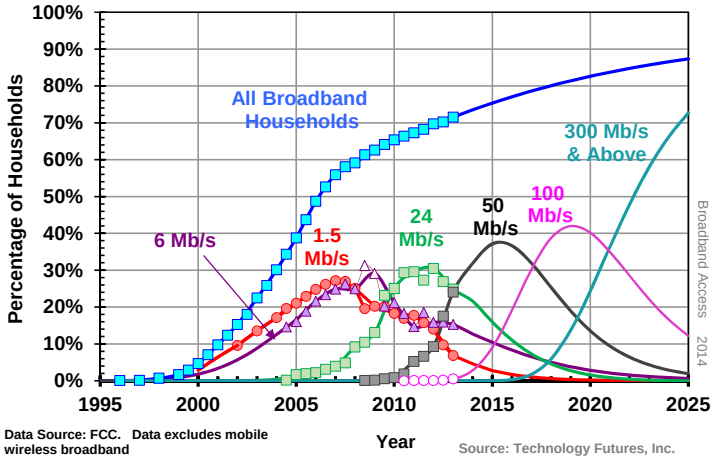
## U.S. Broadband Lifecycles (Residential Subscribers)




Data Source: FCC. Data excludes mobile wireless broadband

Source: Technology Futures, Inc.

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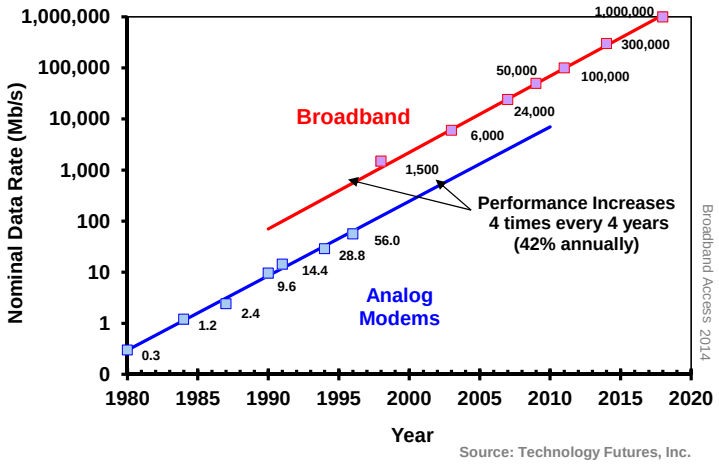
# Trend in Residential Access Data Rates




Source: Technology Futures, Inc.

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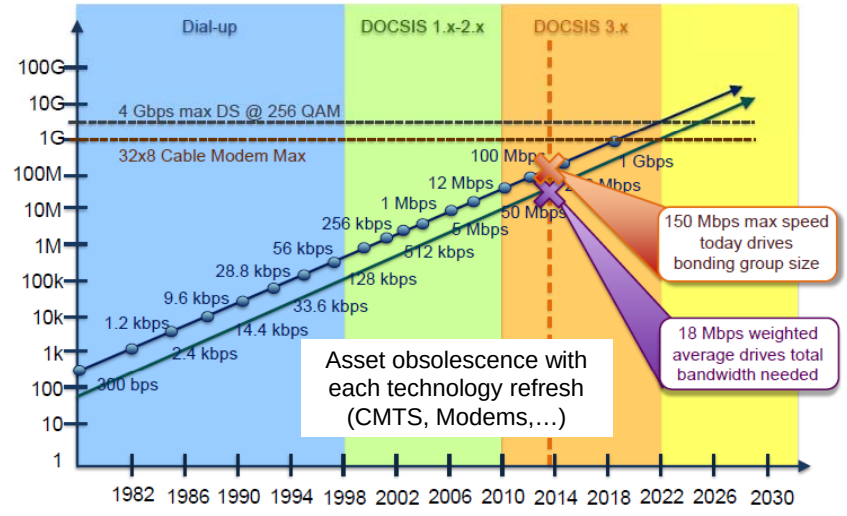
# High Speed Data Consumer Speeds




*Source: Jeff Finkelstein, Cox Communication*

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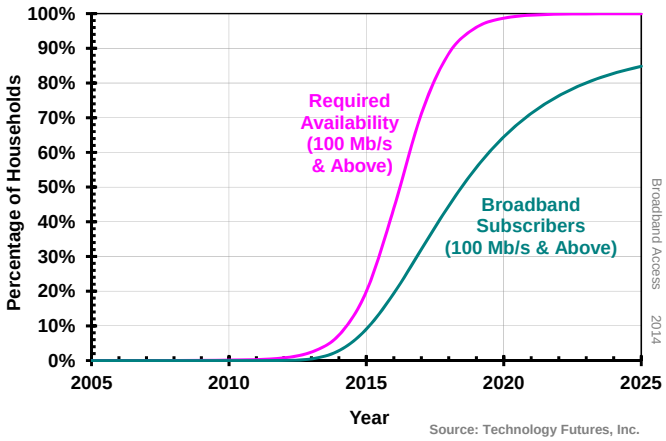
# Availability vs Subscribers, 100 Mb/s & Above




Source: Technology Futures, Inc.

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# Options for Increasing Bandwidth

- Upgrade Hybrid Fiber Coax (HFC)
  - Node splits
  - Increase DOCSIS 3.0 channels
  - Migrate from DOCSIS 3.0 to DOCSIS 3.1
  - Go Fiber Deep
  - These are not mutually exclusive
  - They involve electronics upgrades, additional fiber cable, and some coax displacement, i.e., additional cost and obsolescence
- Switch to Fiber to the Home (FTTH)
  - Complete replacement of all HFC assets
  - Large capital expense, but significant operations cost savings
  - Gigabit capability now + room to grow
  - All the cool kids are doing it

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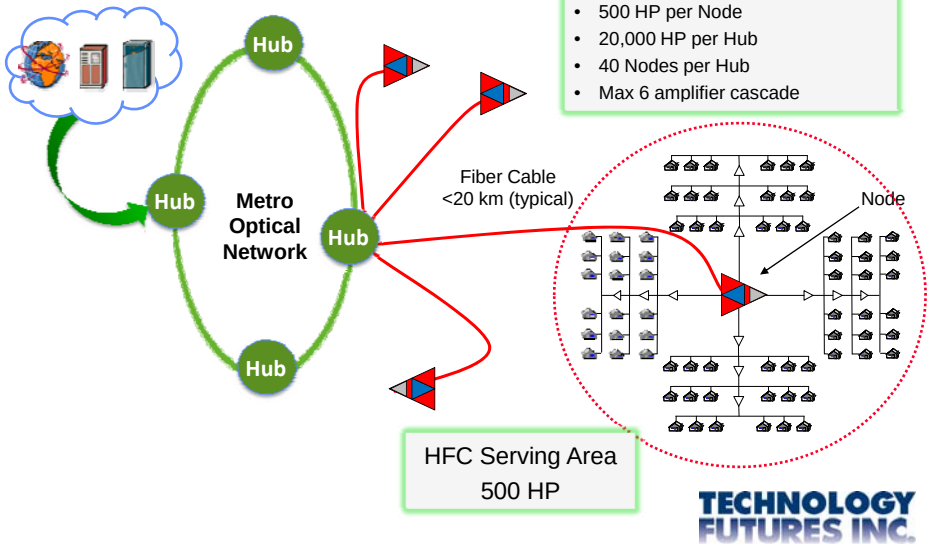
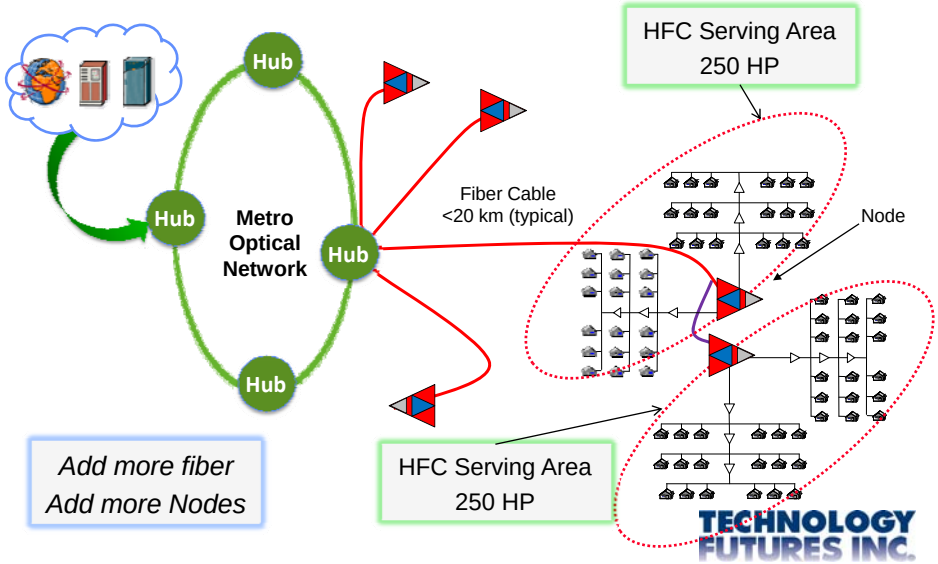
# Typical HFC Access Network



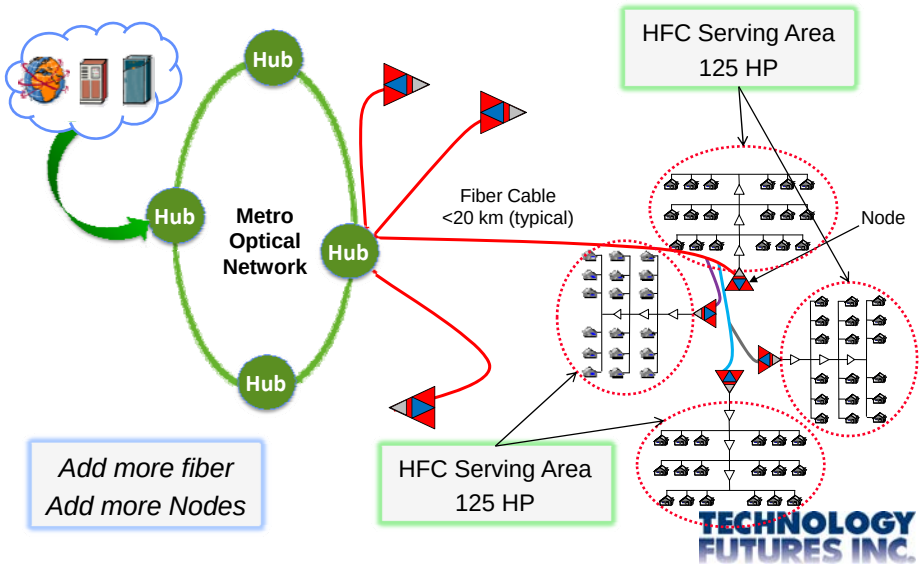

 

# Node Split to Reduce Service Group Size



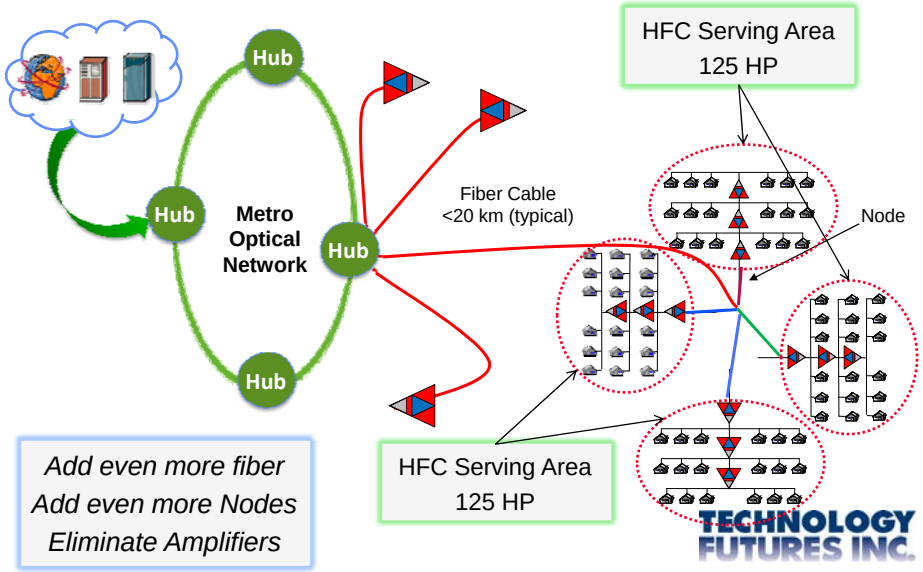

 

## Node Split to Reduce Service Group Size



## Go to Fiber Deep



# DOCSIS 3.0 Data Rates

| | Channel configuration | | Usable Throughput | |
|---|---|---|---|---|
| Status | Number of downstream channels | Number of upstream channels | Downstream | Upstream |
| Minimum | 4 | 4 | 152 Mbit/s | 108 Mbit/s |
| Typical Today | 8 | 4 | 304 Mbit/s | 108 Mbit/s |
| Available | 16 | 4 | 608 Mbit/s | 108 Mbit/s |
| Available | 24 | 8 | 912 Mbit/s | 216 Mbit/s |
| Coming | 32 | 8 | 1.6 Gb/s | 216 Mbit/s |

One 6 MHz channel = 38 Mb/s Downstream

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# Future Potential of DOCSIS 3.1

| | Parameter | Now | Phase 1 | Phase 2 | Phase 3 |
|---|---|---|---|---|---|
| Downstream | Frequency Band | 54 - 1002 MHz | 108 - 1002 MHz | (300) - 1002 MHz | (500) - 1700 MHz |
| | Modulation | 256-QAM | 256-QAM | ≥ 1024-QAM | ≥ 1024-QAM |
| | Channels | 8 | 24 | 116 | 200 |
| | Data Capacity | 300 Mbps | 1 Gbps | 5 Gbps | 10 Gbps |
| Upstream | Frequency Band | 5 - 42 MHz | 5 - 85 MHz | 5 - (230) MHz | 5 - (400) MHz |
| | Modulation | 64-QAM | 64-QAM | ≥ 256 QAM | ≥ 1024 QAM |
| | Channels | 4 | 12 | 33 | 55 |
| | Data Capacity | 100 Mbps | 300 Mbps | 1 Gbps | (2) Gbps |

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# HFC vs. FTTH OPEX per Mile of Plant

| | HFC | FTTH |
|---|---|---|
| Technical Supervision | $ 42.03 | $ 10.51 |
| Service Trouble Truck Rolls (for plant problems) | $ 226.15 | $ - |
| Plant Maintenance Truck Rolls | $ 235.50 | $ - |
| Material Inventory | $ 49.64 | $ 4.90 |
| Electricity Consumption | $ 446.81 | $ - |
| Power Supply Battery Replacement | $ 43.49 | $ - |
| Power Supply Equipment Repair | $ 1.77 | $ - |
| RF Line Equipment Repair | $ 35.46 | $ - |
| Vehicle Accident Loss | $ 8.80 | $ - |
| Employee Injury Loss | $ 5.01 | $ - |
| Emergency Cable Repair | $ 8.51 | $ 85.11 |
| Total annual O&M expense per mile of OSP plant | **$ 1,103.17** | **$ 100.52** |

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# For Comcast we assume Fiber Deep is the choice over FTTH for existing neighborhoods. This could change over time.

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## Estimating HFC Asset Lives and Percent Goods

- Technology Substitution
- Physical Mortality
- Technology Obsolescence
- Cost Index (Trend Factor)

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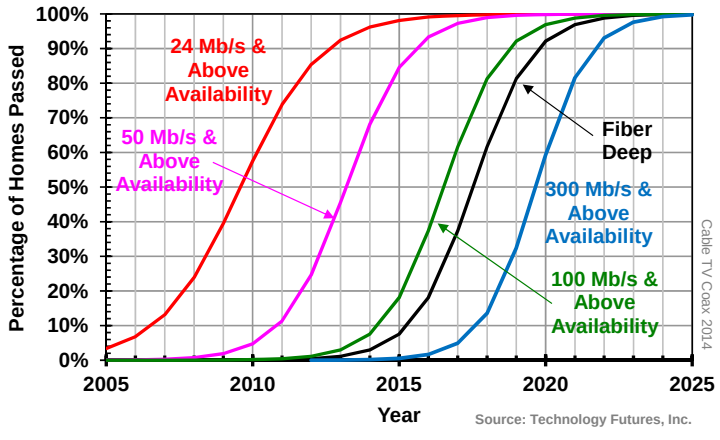
## Availability Requirement 100 Mb/s and Forecasted Fiber Deep Adoption

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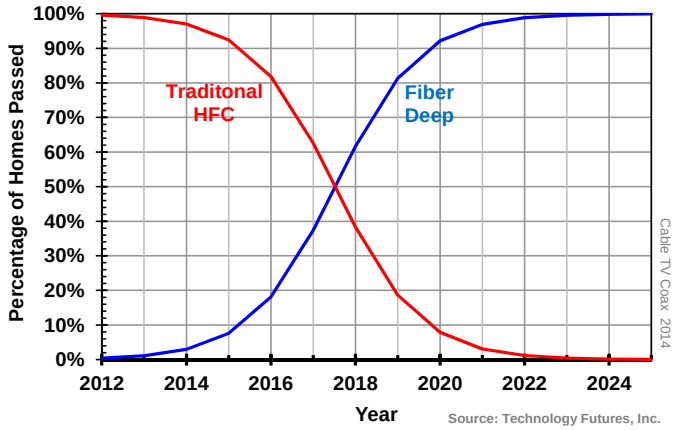
# Forecast of Homes Passed by Fiber Deep and Traditional HFC




Source: Technology Futures, Inc.

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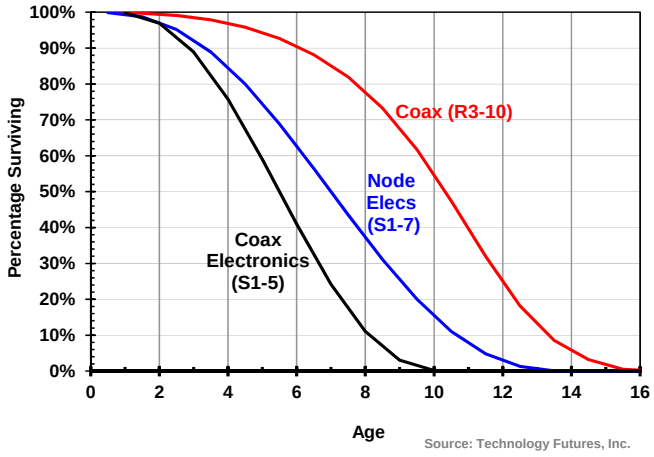
# Physical Mortality for HFC Assets, Iowa Curves




Source: Technology Futures, Inc.

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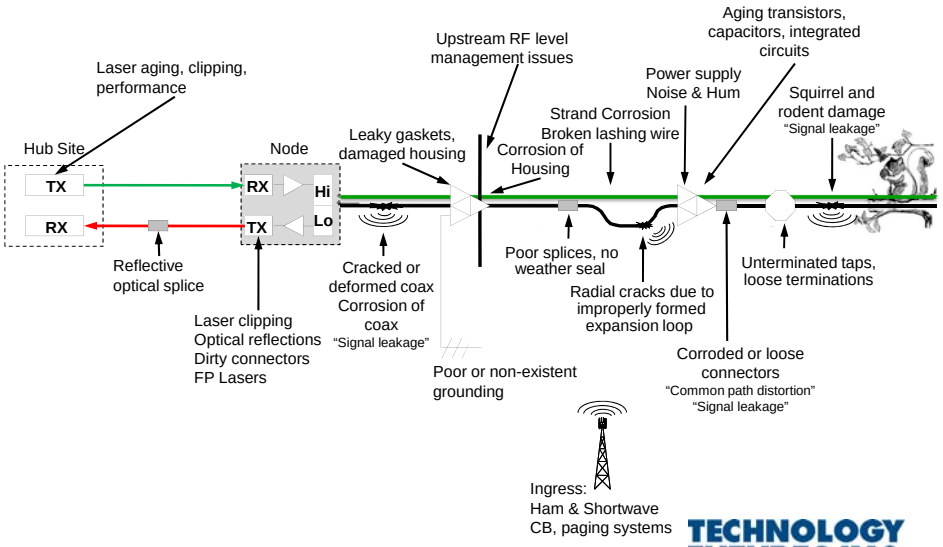
# Issues from HFC Plant Aging

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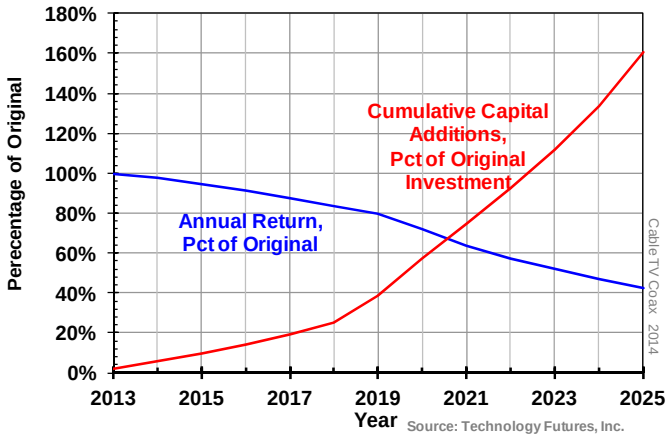
# Technology Obsolescence for HFC Assets

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# CostQuest Trend Factors (Original)

| | Converter | HeadEnd Electronics | Access Electronics | Poles | Power | Aerial Coax | Aerial Fiber | Buried Coax | Buried Fiber | Submarine | Drop-Terminal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 0.343 | 0.584 | 0.417 | 1.003 | 1.074 | 1.446 | 1.345 | 1.165 | 1.092 | 1.092 | 0.505 |
| 1999 | 0.367 | 0.587 | 0.429 | 1.002 | 1.07 | 1.405 | 1.311 | 1.152 | 1.085 | 1.085 | 0.53 |
| 2000 | 0.394 | 0.582 | 0.438 | 0.999 | 1.057 | 1.337 | 1.251 | 1.14 | 1.078 | 1.078 | 0.557 |
| 2001 | 0.424 | 0.586 | 0.453 | 1.035 | 1.052 | 1.29 | 1.21 | 1.127 | 1.07 | 1.07 | 0.585 |
| 2002 | 0.456 | 0.596 | 0.473 | 1.035 | 1.048 | 1.254 | 1.182 | 1.115 | 1.063 | 1.063 | 0.614 |
| 2003 | 0.49 | 0.622 | 0.511 | 1.033 | 1.048 | 1.218 | 1.157 | 1.104 | 1.06 | 1.06 | 0.645 |
| 2004 | 0.526 | 0.645 | 0.543 | 1.031 | 1.05 | 1.191 | 1.143 | 1.092 | 1.057 | 1.057 | 0.677 |
| 2005 | 0.566 | 0.669 | 0.579 | 1.029 | 1.042 | 1.154 | 1.108 | 1.081 | 1.047 | 1.047 | 0.711 |
| 2006 | 0.585 | 0.689 | 0.61 | 1.041 | 1.019 | 1.12 | 1.076 | 1.069 | 1.038 | 1.038 | 0.746 |
| 2007 | 0.571 | 0.714 | 0.647 | 1.052 | 1.017 | 1.088 | 1.045 | 1.061 | 1.03 | 1.03 | 0.784 |
| 2008 | 0.665 | 0.743 | 0.687 | 1.106 | 1.011 | 1.062 | 1.031 | 1.052 | 1.03 | 1.03 | 0.823 |
| 2009 | 0.687 | 0.797 | 0.753 | 1.067 | 1.009 | 1.043 | 1.03 | 1.033 | 1.024 | 1.024 | 0.864 |
| 2010 | 0.866 | 0.853 | 0.82 | 1.041 | 1.008 | 1.036 | 1.025 | 1.025 | 1.017 | 1.017 | 0.907 |
| 2011 | 0.896 | 0.927 | 0.911 | 1.043 | 1.004 | 1.012 | 1.013 | 1.009 | 1.009 | 1.009 | 0.952 |
| 2012 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

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# CostQuest Trend Factors (Forecast for 2013 and Index Scaled to 2013)

| | Converter | HeadEnd Electronics | Access Electronics | Aerial Coax | Aerial Fiber | Buried Coax | Buried Fiber |
|---|---|---|---|---|---|---|---|
| 1998 | 0.305 | 0.544 | 0.380 | 1.468 | 1.350 | 1.182 | 1.099 |
| 1999 | 0.326 | 0.546 | 0.391 | 1.427 | 1.316 | 1.168 | 1.092 |
| 2000 | 0.350 | 0.542 | 0.399 | 1.358 | 1.256 | 1.156 | 1.085 |
| 2001 | 0.377 | 0.545 | 0.413 | 1.310 | 1.215 | 1.143 | 1.077 |
| 2002 | 0.406 | 0.555 | 0.431 | 1.273 | 1.186 | 1.131 | 1.070 |
| 2003 | 0.436 | 0.579 | 0.466 | 1.237 | 1.161 | 1.120 | 1.067 |
| 2004 | 0.468 | 0.600 | 0.495 | 1.209 | 1.147 | 1.108 | 1.064 |
| 2005 | 0.503 | 0.623 | 0.528 | 1.172 | 1.112 | 1.096 | 1.054 |
| 2006 | 0.520 | 0.641 | 0.556 | 1.137 | 1.080 | 1.084 | 1.045 |
| 2007 | 0.508 | 0.665 | 0.590 | 1.105 | 1.049 | 1.076 | 1.037 |
| 2008 | 0.592 | 0.692 | 0.626 | 1.078 | 1.035 | 1.067 | 1.037 |
| 2009 | 0.611 | 0.742 | 0.687 | 1.059 | 1.034 | 1.048 | 1.031 |
| 2010 | 0.770 | 0.794 | 0.748 | 1.052 | 1.029 | 1.040 | 1.023 |
| 2011 | 0.797 | 0.863 | 0.831 | 1.028 | 1.017 | 1.023 | 1.015 |
| 2012 | 0.890 | 0.931 | 0.912 | 1.015 | 1.004 | 1.014 | 1.006 |
| 2013 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

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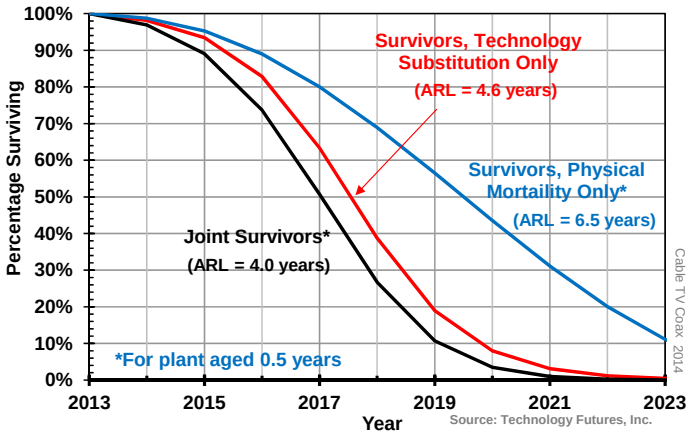
## Lives and Percent Good for HFC Electronics

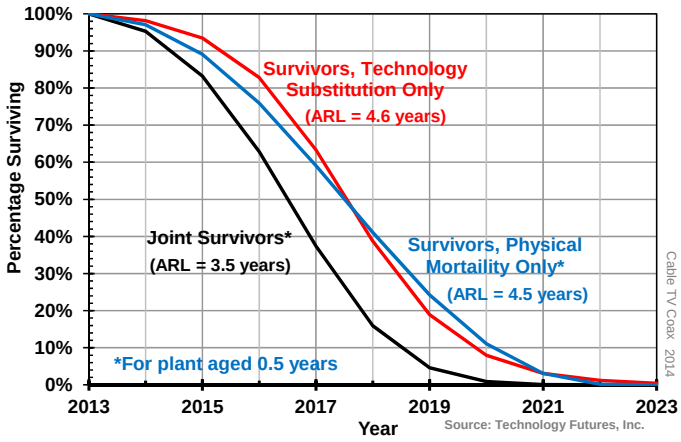
## Node Electronics, Physical Mortality & Tech Substitution, New Plant (Age = 0.5)




Note: Additional Technology Obsolescence Factor reduces ARL to 3.7 years

# Coax Electronics, Physical Mortality & Tech Substitution, New Plant (Age = 0.5)




Note: Additional Technology Obsolescence Factor reduces ARL to 3.2 years

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# Percent Good Calculations for Comcast HFC Electronics (Untrended)

**Node Electronics**

| Year | Age | Rem Life | Service Life | Pct Good |
|---|---|---|---|---|
| 2013 | 0.5 | 3.7 | 4.2 | 88% |
| 2012 | 1.5 | 3.4 | 4.9 | 70% |
| 2011 | 2.5 | 3.2 | 5.7 | 56% |
| 2010 | 3.5 | 2.9 | 6.4 | 45% |
| 2009 | 4.5 | 2.6 | 7.1 | 37% |
| 2008 | 5.5 | 2.4 | 7.9 | 30% |
| 2007 | 6.5 | 2.1 | 8.6 | 25% |
| 2006 | 7.5 | 1.8 | 9.3 | 20% |
| 2005 | 8.5 | 1.6 | 10.1 | 15% |
| 2004 | 9.5 | 1.3 | 10.8 | 12% |
| 2003 | 10.5 | 1.0 | 11.5 | 9% |
| 2002 | 11.5 | 0.8 | 12.3 | 6% |
| 2001 | 12.5 | 0.6 | 13.1 | 4% |
| 2000 | 13.5 | 0.5 | 14.0 | 4% |

**Coax Electronics**

| Year | Age | Rem Life | Service Life | Pct Good |
|---|---|---|---|---|
| 2013 | 0.5 | 3.2 | 3.7 | 87% |
| 2012 | 1.5 | 2.8 | 4.3 | 65% |
| 2011 | 2.5 | 2.4 | 4.9 | 49% |
| 2010 | 3.5 | 2.0 | 5.5 | 37% |
| 2009 | 4.5 | 1.7 | 6.2 | 27% |
| 2008 | 5.5 | 1.4 | 6.9 | 20% |
| 2007 | 6.5 | 1.0 | 7.5 | 14% |
| 2006 | 7.5 | 0.8 | 8.3 | 9% |
| 2005 | 8.5 | 0.5 | 9.0 | 6% |
| 2004 | 9.5 | 0.5 | 10.0 | 5% |
| 2003 | 10.5 | 0.0 | 10.5 | 0% |
| 2002 | 11.5 | 0.0 | 11.5 | 0% |
| 2001 | 12.5 | 0.0 | 12.5 | 0% |
| 2000 | 13.5 | 0.0 | 13.5 | 0% |

**Source: Technology Futures, Inc.**

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# Percent Good Calculations for Comcast HFC Electronics (Trended)

| Node Electronics | | | |
|---|---|---|---|
| Year | Pct Good Untrended | Trend Factor | Pct Good Trended |
| 2013 | 88% | 0.96 | 84% |
| 2012 | 70% | 0.87 | 61% |
| 2011 | 56% | 0.79 | 44% |
| 2010 | 45% | 0.72 | 33% |
| 2009 | 37% | 0.66 | 24% |
| 2008 | 30% | 0.61 | 18% |
| 2007 | 25% | 0.57 | 14% |
| 2006 | 20% | 0.54 | 11% |
| 2005 | 15% | 0.51 | 8% |
| 2004 | 12% | 0.48 | 6% |
| 2003 | 9% | 0.45 | 4% |
| 2002 | 6% | 0.42 | 3% |
| 2001 | 4% | 0.41 | 2% |
| 2000 | 4% | 0.39 | 1% |

| Coax Electronics | | | |
|---|---|---|---|
| Year | Pct Good Untrended | Trend Factor | Pct Good Trended |
| 2013 | 87% | 0.96 | 83% |
| 2012 | 65% | 0.87 | 57% |
| 2011 | 49% | 0.79 | 39% |
| 2010 | 37% | 0.72 | 26% |
| 2009 | 27% | 0.66 | 18% |
| 2008 | 20% | 0.61 | 12% |
| 2007 | 14% | 0.57 | 8% |
| 2006 | 9% | 0.54 | 5% |
| 2005 | 6% | 0.51 | 3% |
| 2004 | 5% | 0.48 | 2% |
| 2003 | 0% | 0.45 | 0% |
| 2002 | 0% | 0.42 | 0% |
| 2001 | 0% | 0.41 | 0% |
| 2000 | 0% | 0.39 | 0% |

**Note: Trend factor assumes mid-year placement**

**Source: Technology Futures, Inc.**
**Trend Factor Source: CostQuest Associates**

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# Lives and Percent Good for HFC Coaxial Cable

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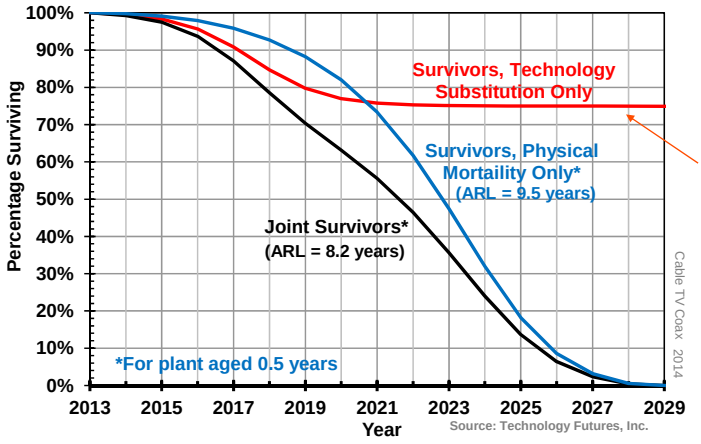
# Coaxial Cable, Physical Mortality & Tech Substitution, New Plant (Age = 0.5)




Assumes Fiber Deep, Not FTTH

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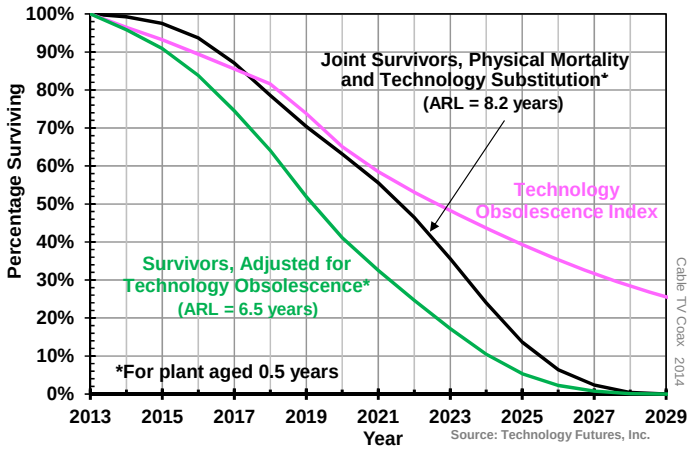
# Coax Cable, Adjusted for Technology Obsolescence, New Plant (Age = 0.5)




Assumes Fiber Deep, Not FTTH

Note: Additional Technology Obsolescence Factor reduces ARL to 6.5 years

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# Percent Good Calculations for Comcast Coaxial Cable (Untrended)

Coax Cable

| Year | Age | Rem Life | Service Life | Pct Good |
|---|---|---|---|---|
| 2013 | 0.5 | 6.5 | 7.0 | 93% |
| 2012 | 1.5 | 6.0 | 7.5 | 80% |
| 2011 | 2.5 | 5.6 | 8.1 | 69% |
| 2010 | 3.5 | 5.1 | 8.6 | 59% |
| 2009 | 4.5 | 4.6 | 9.1 | 51% |
| 2008 | 5.5 | 4.1 | 9.6 | 43% |
| 2007 | 6.5 | 3.6 | 10.1 | 36% |
| 2006 | 7.5 | 3.1 | 10.6 | 29% |
| 2005 | 8.5 | 2.6 | 11.1 | 23% |
| 2004 | 9.5 | 2.1 | 11.6 | 18% |
| 2003 | 10.5 | 1.7 | 12.2 | 14% |
| 2002 | 11.5 | 1.4 | 12.9 | 11% |
| 2001 | 12.5 | 1.1 | 13.6 | 8% |
| 2000 | 13.5 | 0.9 | 14.4 | 6% |
| 1999 | 14.5 | 0.7 | 15.2 | 4% |
| 1998 | 15.5 | 0.5 | 16.0 | 3% |
| 1997 | 16.5 | 0.0 | 16.5 | 0% |

Assumes
Fiber Deep,
Not FTTH

**Source: Technology Futures, Inc.**

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# Percent Good Calculations for Comcast Coaxial Cable (Trended)

Coax Cable

| Year | Pct Good Untrended | Tend Factor | Pct Good Trended |
|---|---|---|---|
| 2013 | 93% | 1.01 | 94% |
| 2012 | 80% | 1.02 | 82% |
| 2011 | 69% | 1.04 | 72% |
| 2010 | 59% | 1.05 | 62% |
| 2009 | 51% | 1.06 | 54% |
| 2008 | 43% | 1.08 | 46% |
| 2007 | 36% | 1.10 | 39% |
| 2006 | 29% | 1.13 | 33% |
| 2005 | 23% | 1.16 | 27% |
| 2004 | 18% | 1.18 | 21% |
| 2003 | 14% | 1.20 | 17% |
| 2002 | 11% | 1.23 | 13% |
| 2001 | 8% | 1.26 | 10% |
| 2000 | 6% | 1.30 | 8% |
| 1999 | 4% | 1.34 | 6% |
| 1998 | 3% | 1.37 | 4% |
| 1997 | 0% | 1.40 | 0% |

Assumes
Fiber Deep,
Not FTTH

**Note: Trend factor assumes mid-year placement**

**Source: Technology Futures, Inc.**
**Trend Factor Source: CostQuest Associates**

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