

FTTH Network Economics: Key Parameters Impacting Technology Decisions Networks 2008



Authors: Samrat Kulkarni, Beth Polonsky and Mohamed El-Sayed

Presenter: Mohamed El-Sayed

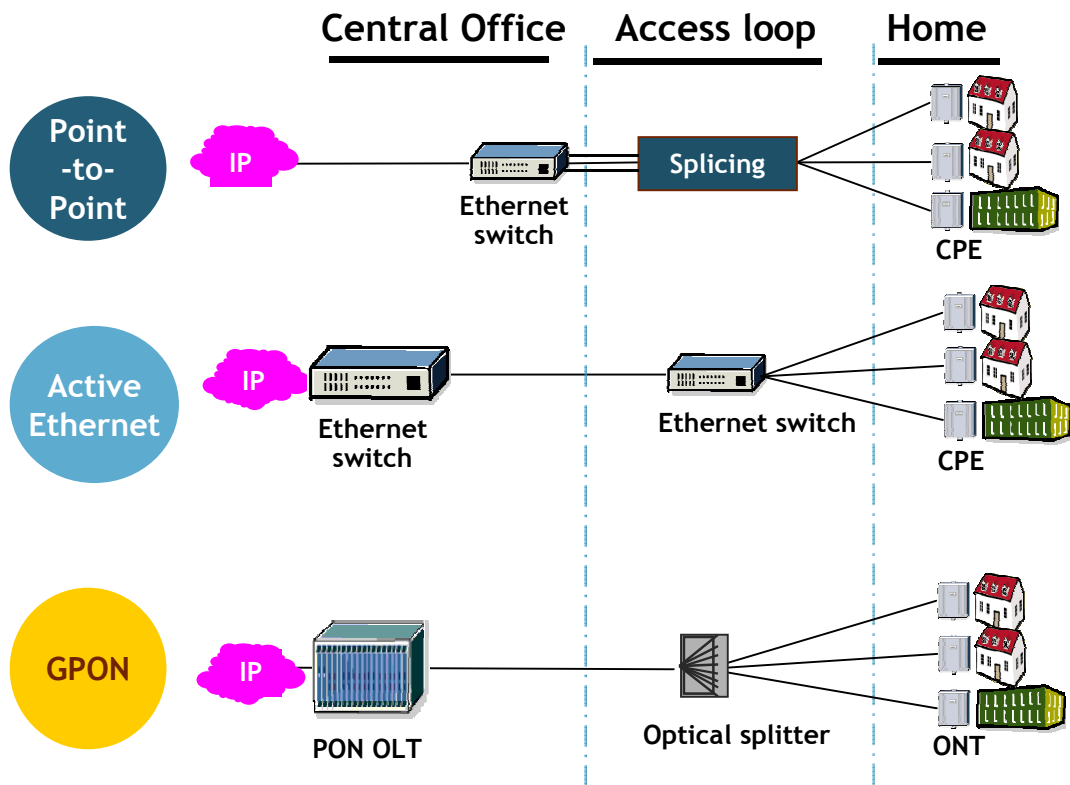
Bell Labs-Network Planning, Performance and Economic Analysis

Outline

- FTTH architectures compared— Point-to-Point (P2P), Active Ethernet (AE), and Gigabit Passive Optical Network (GPON)
 - Input assumptions
 - Modeling Parameters
- GPON vs P2P
 - Reference urban network
 - Capex/Opex modeling results
 - Sensitivity Analysis (Tornado, MonteCarlo)
- GPON vs AE
 - Two cases: Re-use DSL OSP and deploy new OSP cabinets
 - Capex/Opex modeling results
 - Sensitivity Analysis (Tornado, MonteCarlo)
- Summary and Comments

Introduction

- A detailed economic analysis of FTTH across a range of different scenarios and parameters assuming Triple Play services (Voice, Data, Video)
- Three scenarios: multi-dwelling units (MDU), Single Family Residences (SFR) and Enterprise
- Task based operations model



- Small street/pole cabinet
 - No remote powering
 - Less maintenance, truck rolls,...
-
- Few fibers in feeder section
 - Smaller duct sizes, Less RoW,...
 - CO consolidation
-
- Passive OSP
 - CO scalability & Consol. (20+ km)
 - Fiber Cost & Management (P-to-MP)

Traffic Assumptions

- It is assumed that all FTTH technologies support current and short-to-mid term growth for residential subscriber applications
- High-level bandwidth requirements per subscriber used in the model

<i>Service Type</i>	<i>Downstream BW</i>	<i>Upstream BW</i>
2 HDTV or 2 VoD (MPEG-4)*	20 Mbps	0
High-speed Internet Access	10 Mbps	2
VoIP	64 Kbps	64 Kbps
Gaming	2 Mbps	384 Kbps
Total	32.6 Mbps	2.448 Mbps

* Assumes max of 2 TV sets per home

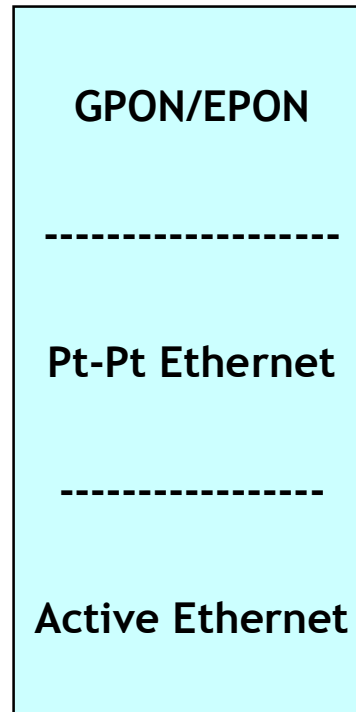
- Standard GPON at a 2.5Gbps line rate and a split ratio of 1:64 provides about 35 Mbps (committed) per user
- Active Ethernet switches are also configured to provide this bandwidth

Typical Modeling Dimensions/Parameters

Scenario Variables

- **Building Type:**
 - Single Family Residential
 - Multi-Dwelling Unit
- **Applications**
 - IP-TV
 - Voice, HSI
 - PTP, Business
- **Housing Density**
 - No of buildings/sq. km
 - Loop length to CO/POP
- **Construction**
 - Greenfield
 - Overbuild
- **Transport Facilities**
 - Fiber owned
 - Leased
- **Outside Plant**
 - Aerial
 - Buried
 - Conduit
- **Drop**
 - Cat5
 - Fiber
- **Splitting Levels**
 - One
 - Two

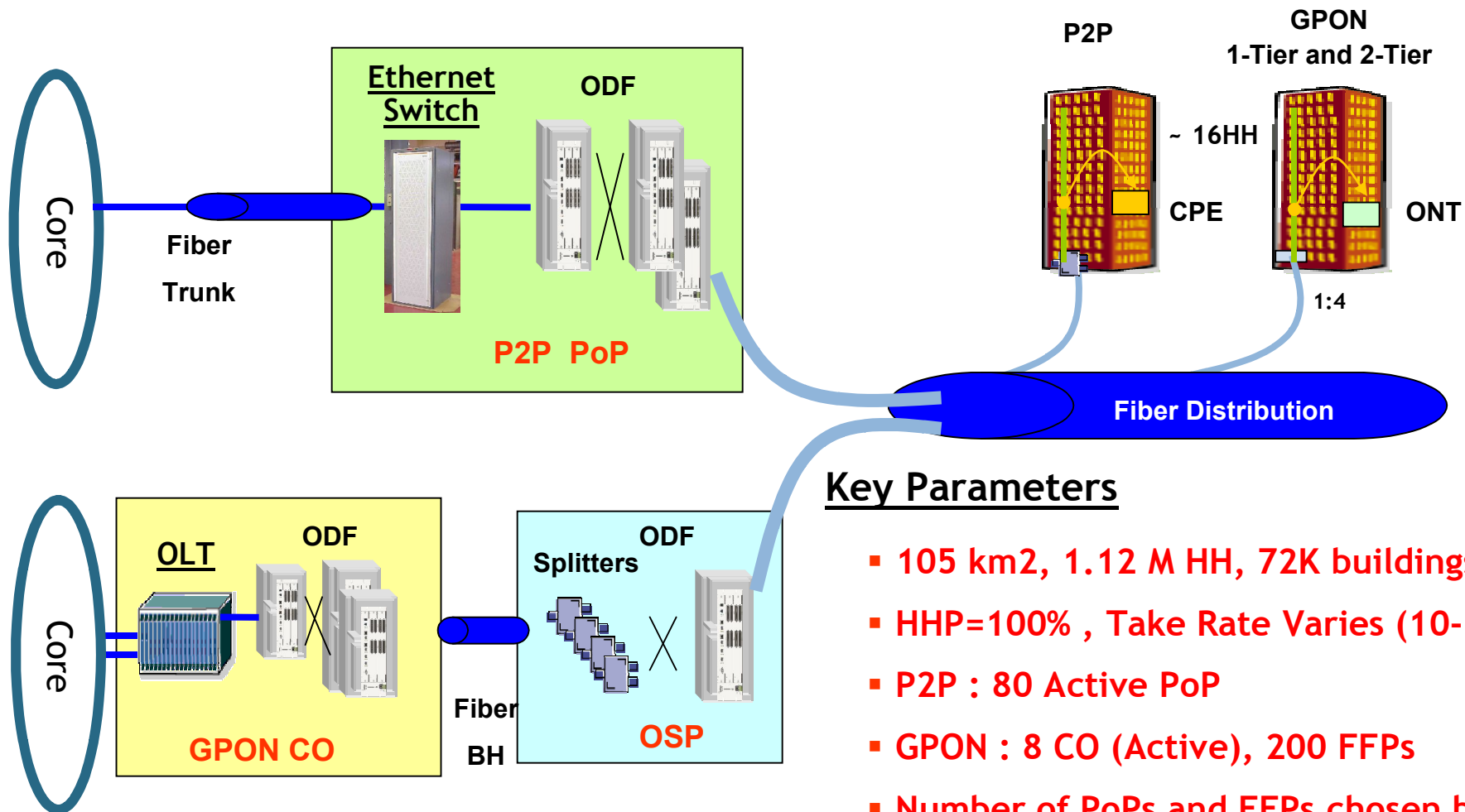
Technologies



Cost Elements

- **Fiber Cables:**
 - Feeder
 - Distribution
 - Drop
- **Civil Work (Feeder, Distribution):**
 - Structures/trenches
 - Splicing, Installation
- **OSP costs**
 - Cabinet, Splitters
 - Fiber Management Point
 - Patch Panel
- **Power and Space**
 - Power node (Active)
 - AC
 - Floor space costs
- **Equipment**
 - CO (shelf, packs, SFP)
 - ODF
 - ONT
 - CPE
- **Activation**
 - Truck roll to OSP
 - Customer service visit
 - Service activation in CO
- **Other Operation Costs**
 - Searching for POP
 - Provisioning activities
 - Maintenance activities
 - etc

Urban MDU Case: Reference Network Architecture

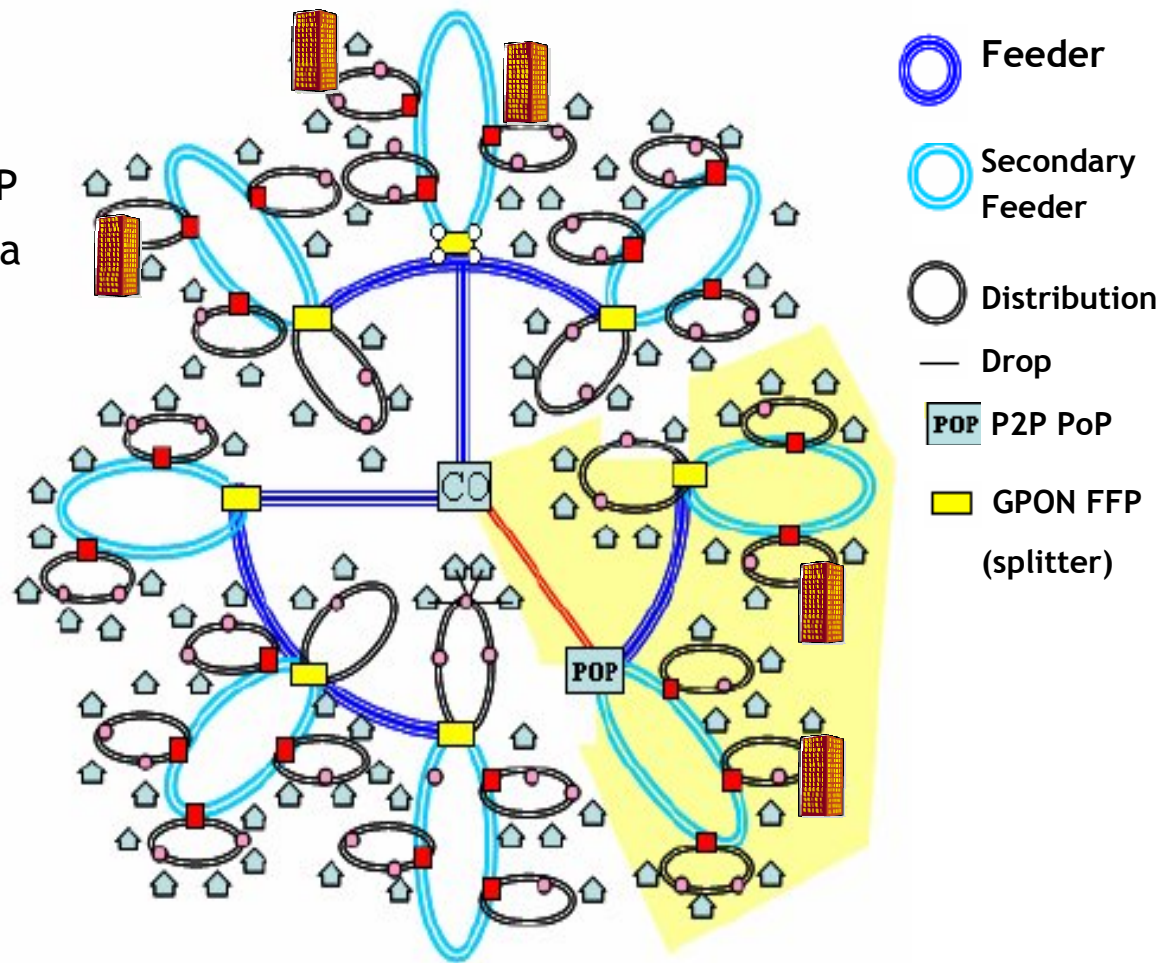


Key Parameters

- 105 km², 1.12 M HH, 72K buildings
- HHP=100% , Take Rate Varies (10-100%)
- P2P : 80 Active PoP
- GPON : 8 CO (Active), 200 FFPs
- Number of PoPs and FFPs chosen based on realistic numbers in the urban area

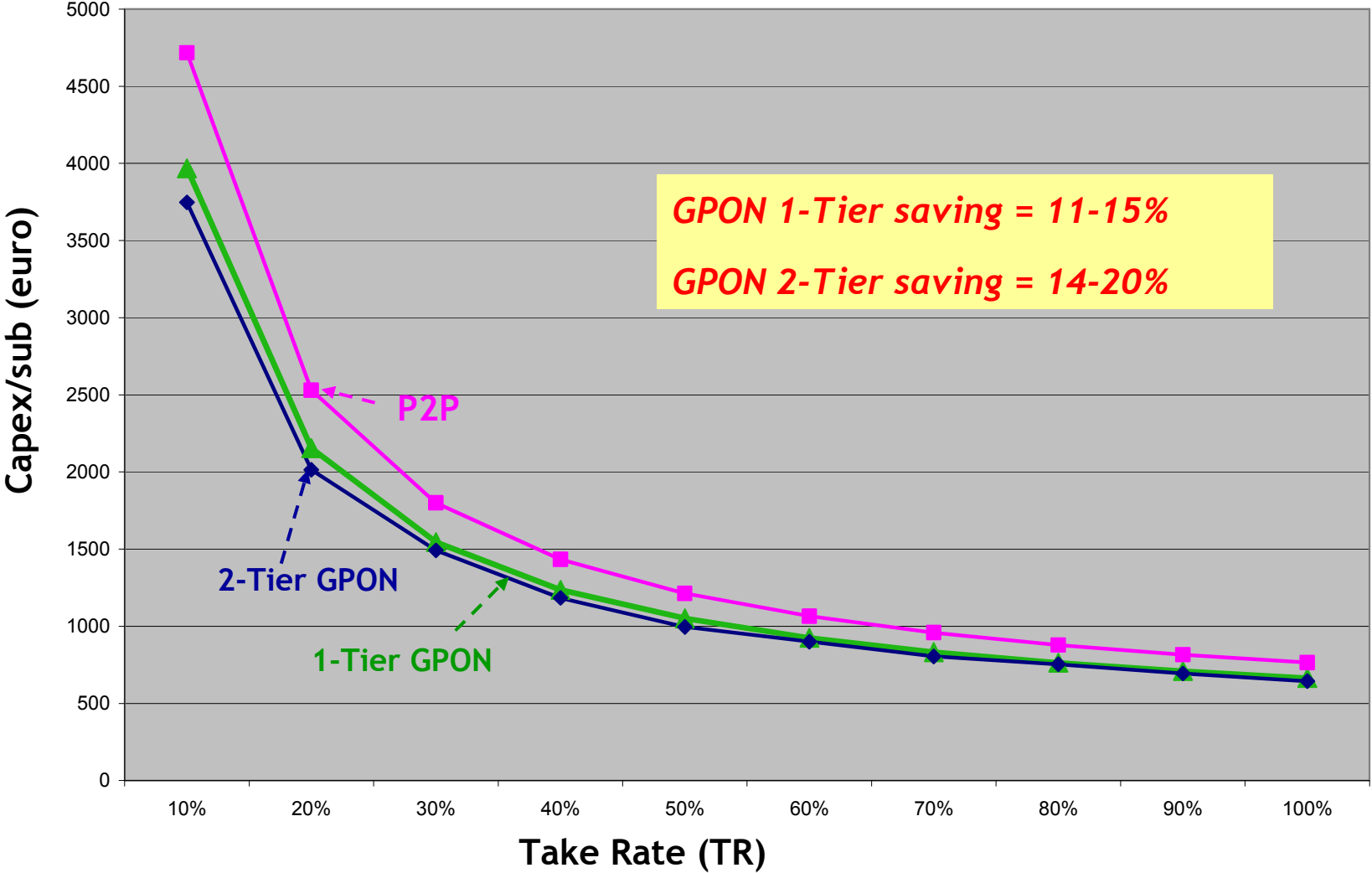
General OSP Modeling Assumptions

- Assumes PoP and FFP located on circumference of circle from CO
- Assumes within each PoP and FFP serving area—homes are also on a circle
- Actual number of FFPs/PoPs depends on availability of real-estate, street-layouts, density etc; model is generic to study effect of different parameters
- Assumes existing civil structures (e.g., sewers, ducts) are used
- Focus on the differences between the technologies; civil works costs assumed to be the same

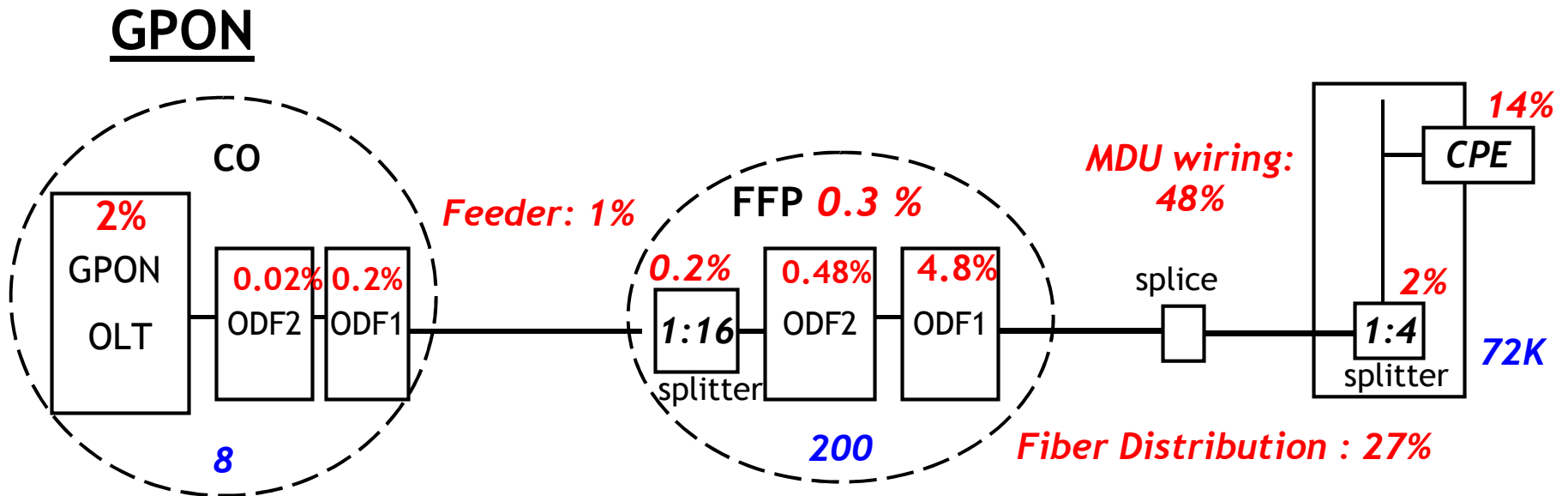
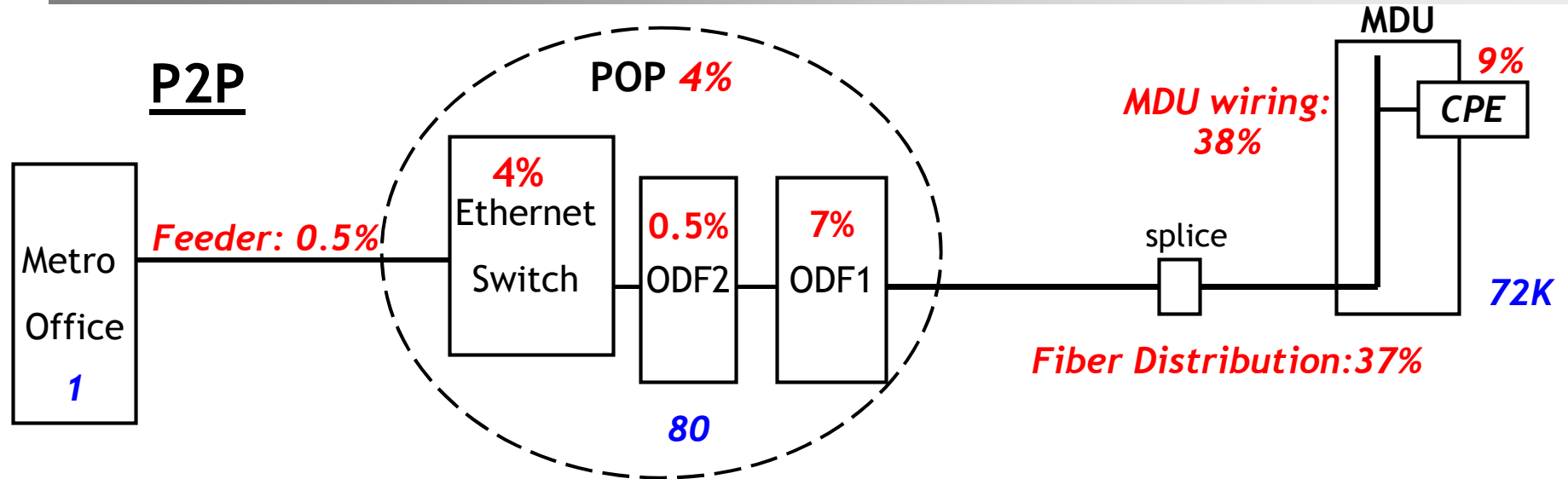


Geographical Model

Urban MDU: Capex/sub



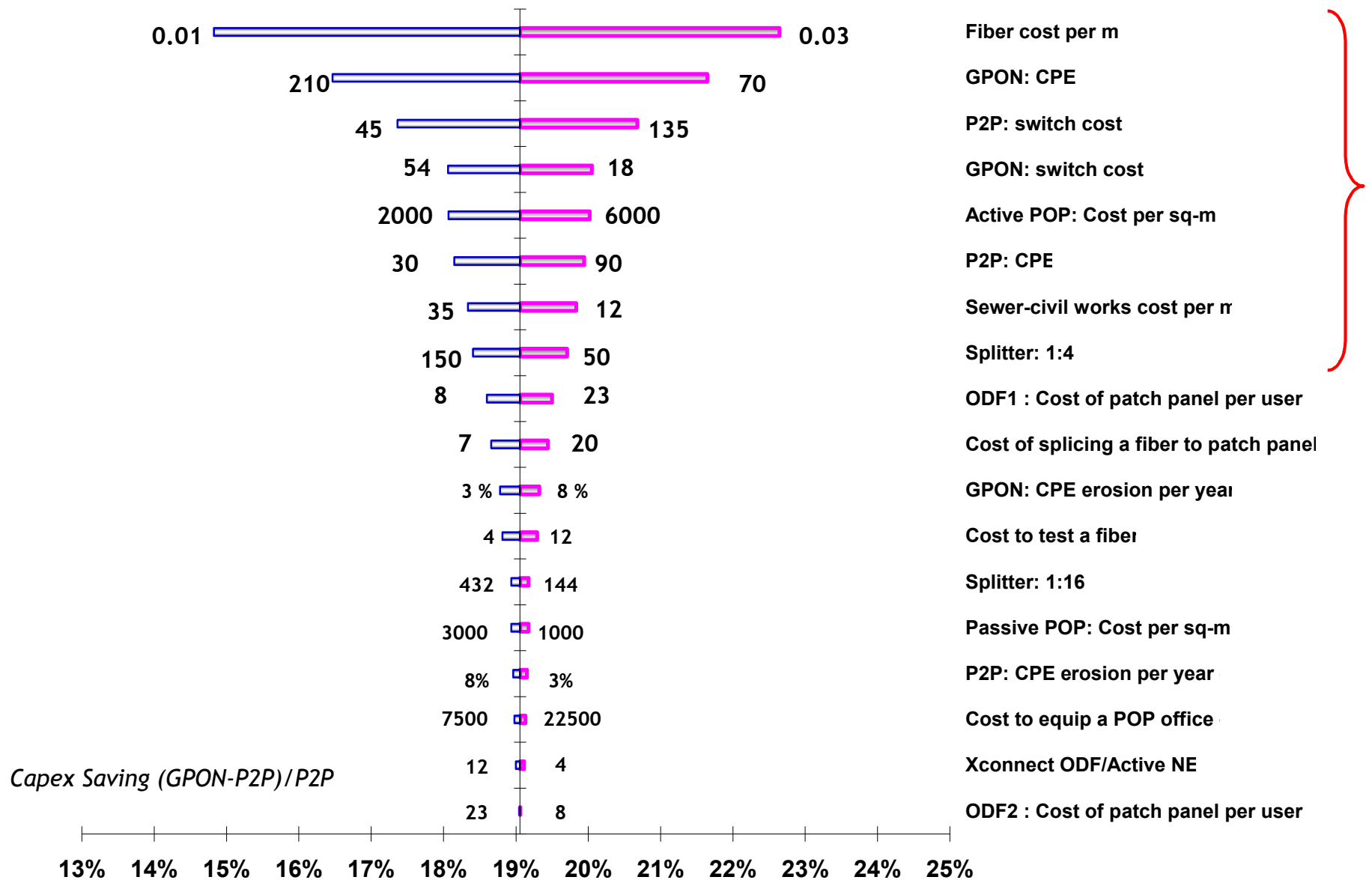
Capex Breakdown at 20% Take Rate



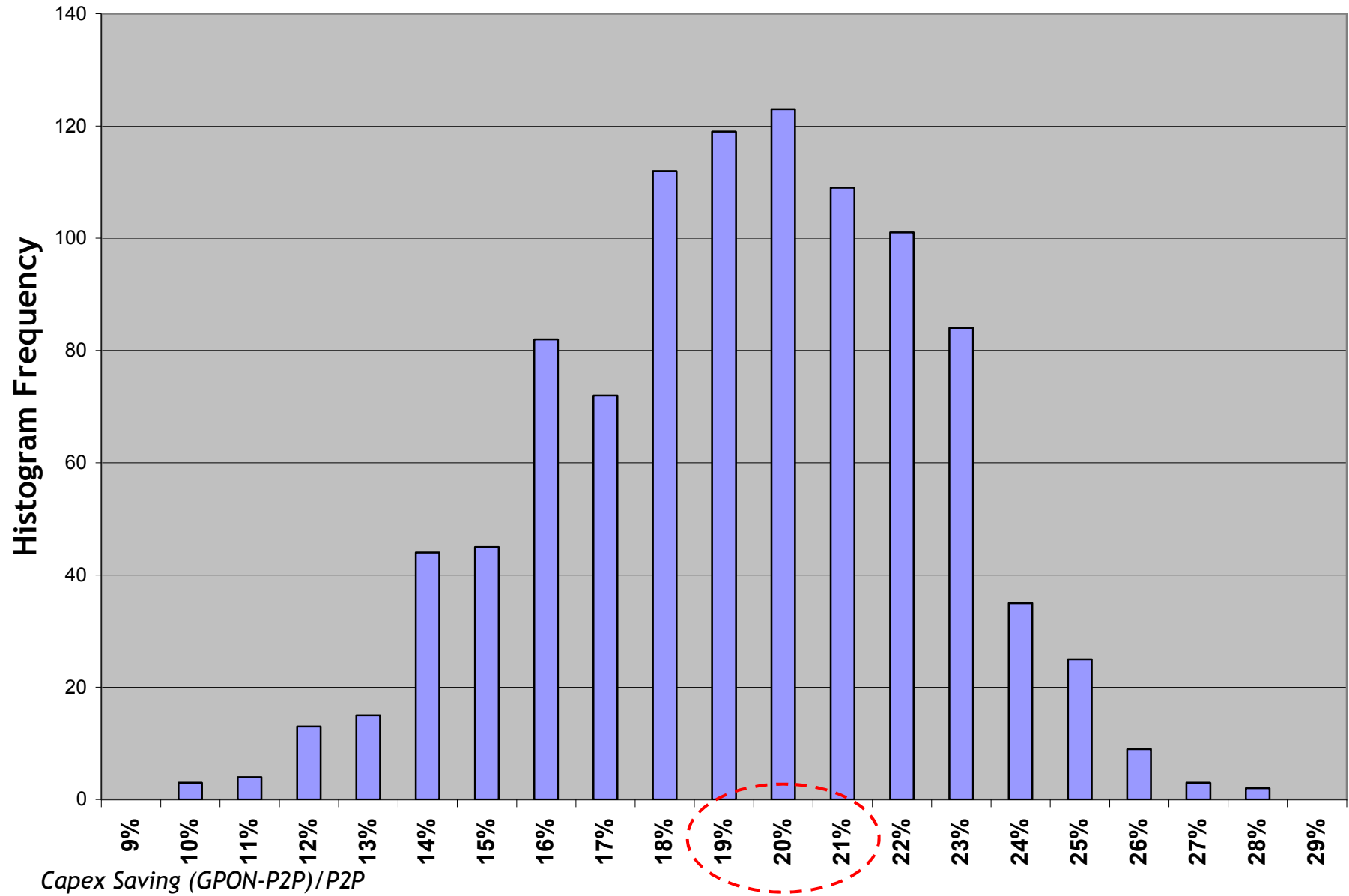
* Blue indicates # of units



Urban MDU: Sensitivity Analysis— Capex/sub (GPON - P2P), 20% TR



Urban MDU: Monte Carlo (1000 iterations) – Capex/sub (GPON - P2P), 20% TR



OPEX Model Components

➤ **Unplanned Maintenance:**

- Repair activity based on equipment quantities and typical FIT data
- Operation Tasks included: Testing, Fault isolation, Equipment Repair (Truck roll)

➤ **Planned Maintenance:**

- Calculated based on equipment quantity, maintenance interval and effort, equipment clustering and location density
- Fiber maintenance based on total length of cables and typical yearly per meter cost
- Operation Tasks included: Battery replacement, Fan Filter replacement, Drive time and paperwork to document preventative maintenance, Fiber inspection/cleaning and debris removal

➤ **Centralized NOC Staffing:**

- Surveillance staff estimated based on total number of active devices.
- Operation Tasks included: 24X7 fault Monitoring, remote diagnostics, trouble ticket creation

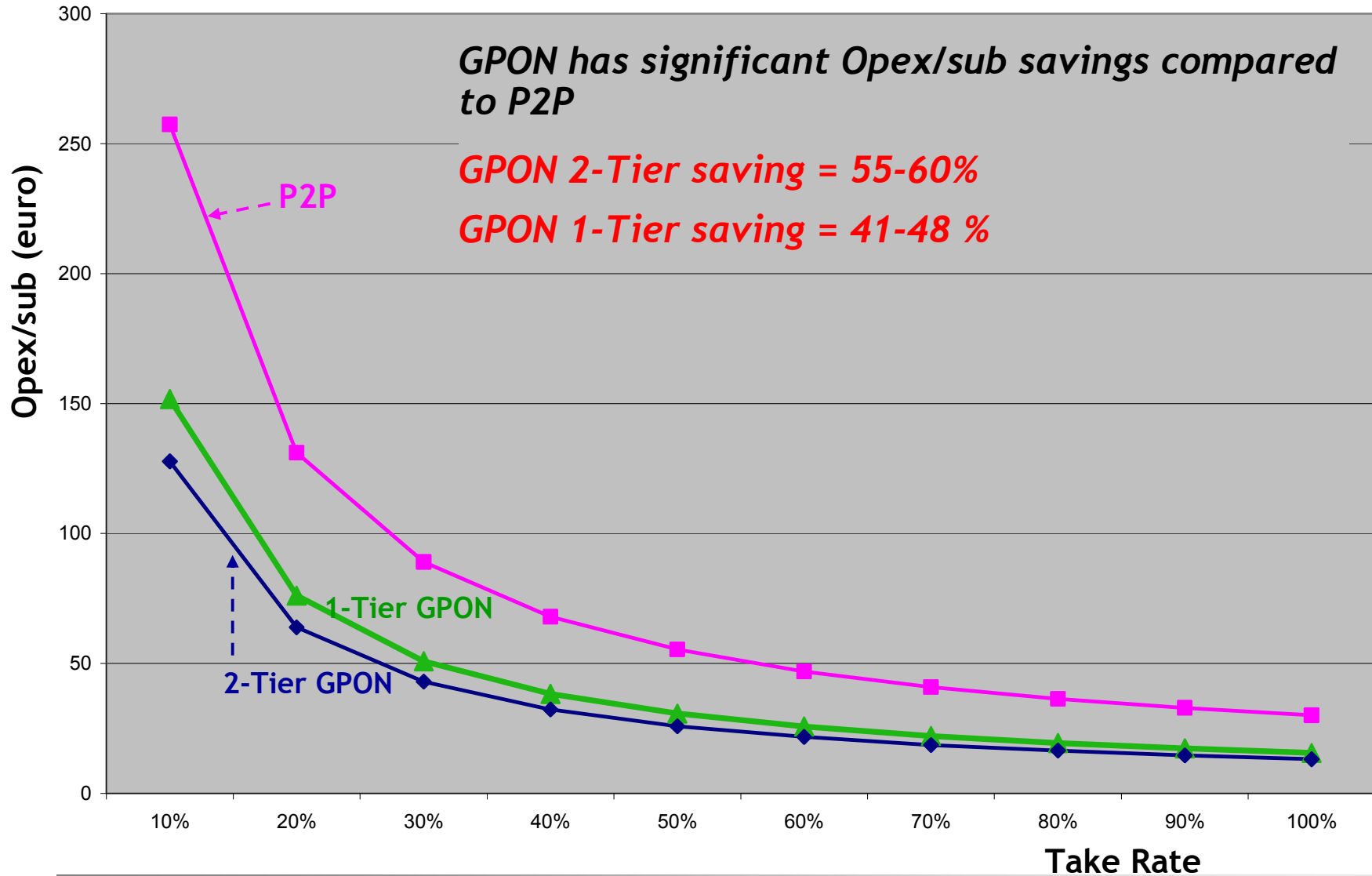
➤ **Customer Care:**

- Estimate based on failure incidence (calculated for unplanned maintenance) and # of customer impacted/incident.
- Operation Tasks included: customer care call handling

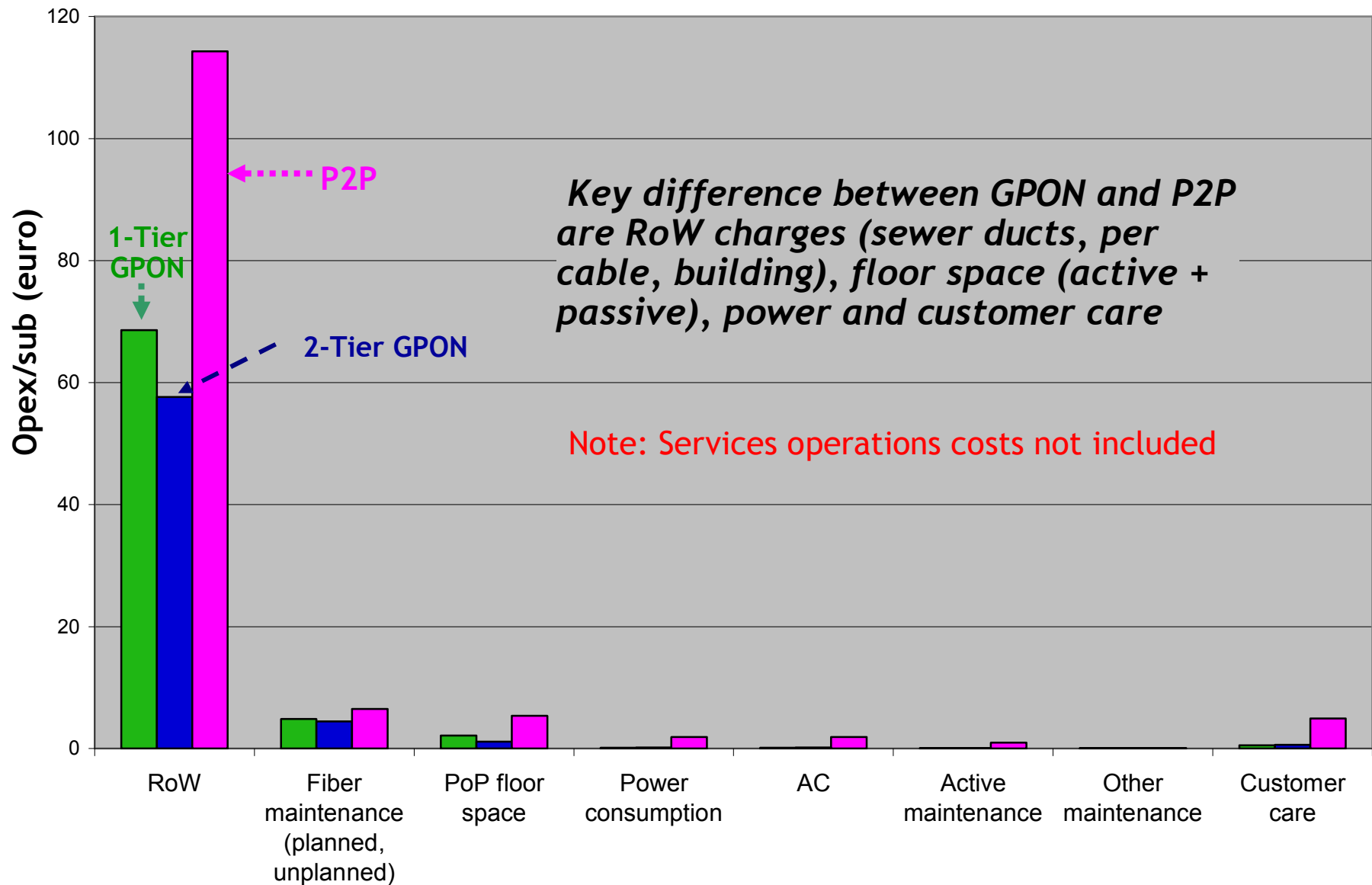
➤ **Differences in Customer Provisioning and Disconnect Scenarios:**

- Cost of connecting/disconnecting a customer based on equipment locations and utilization
- Disconnect cost based on churn rate that are hinged on the number of providers in sharing scenarios
- Operation Tasks included: CPE installation, in-building fiber connection, POP/FFP connections, Testing, Inventory updates

Urban MDU: Opex/sub/year



Urban MDU: Opex/sub/year Breakdown (at 20% Take Rate)

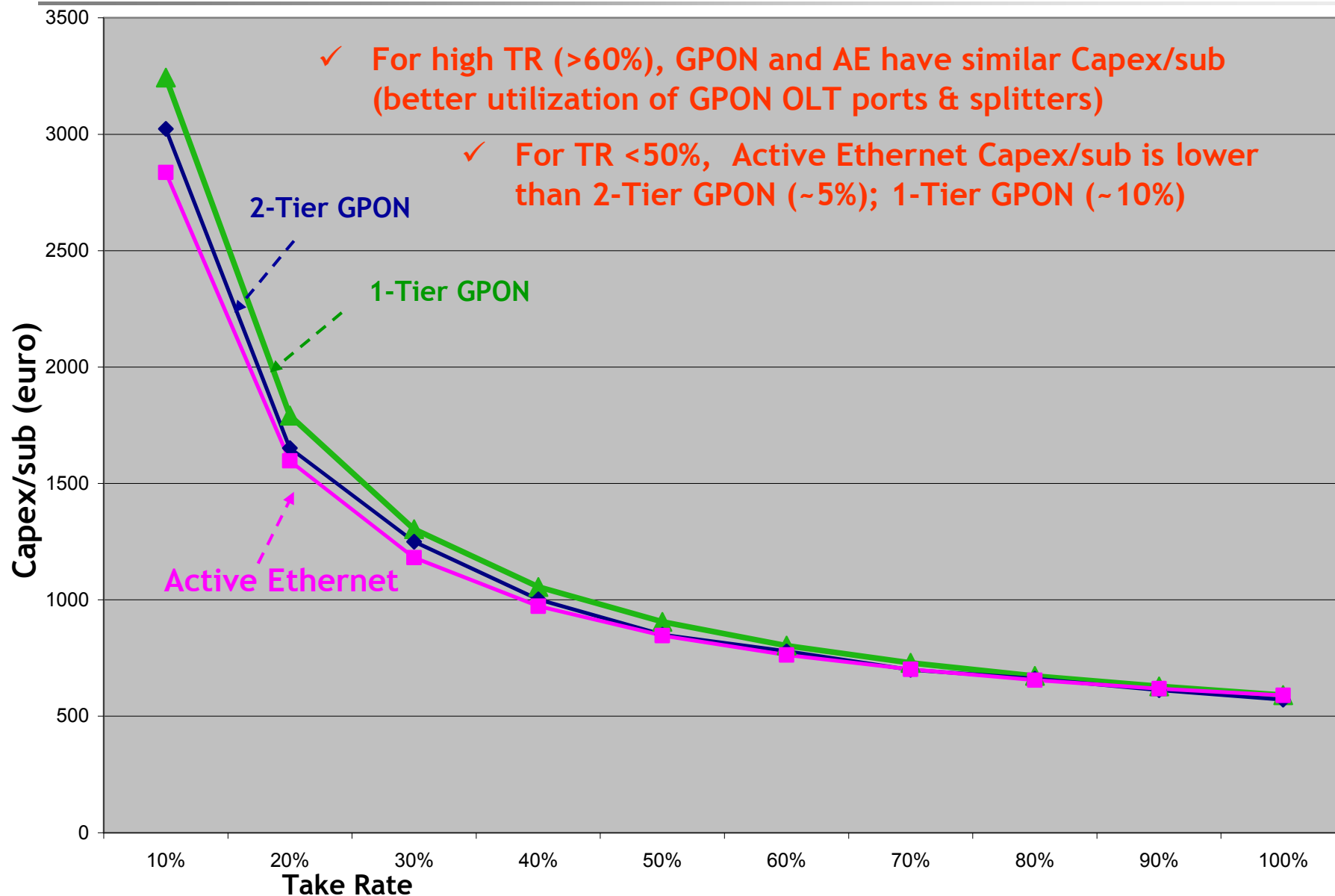


GPON vs AE Example: Urban MDU

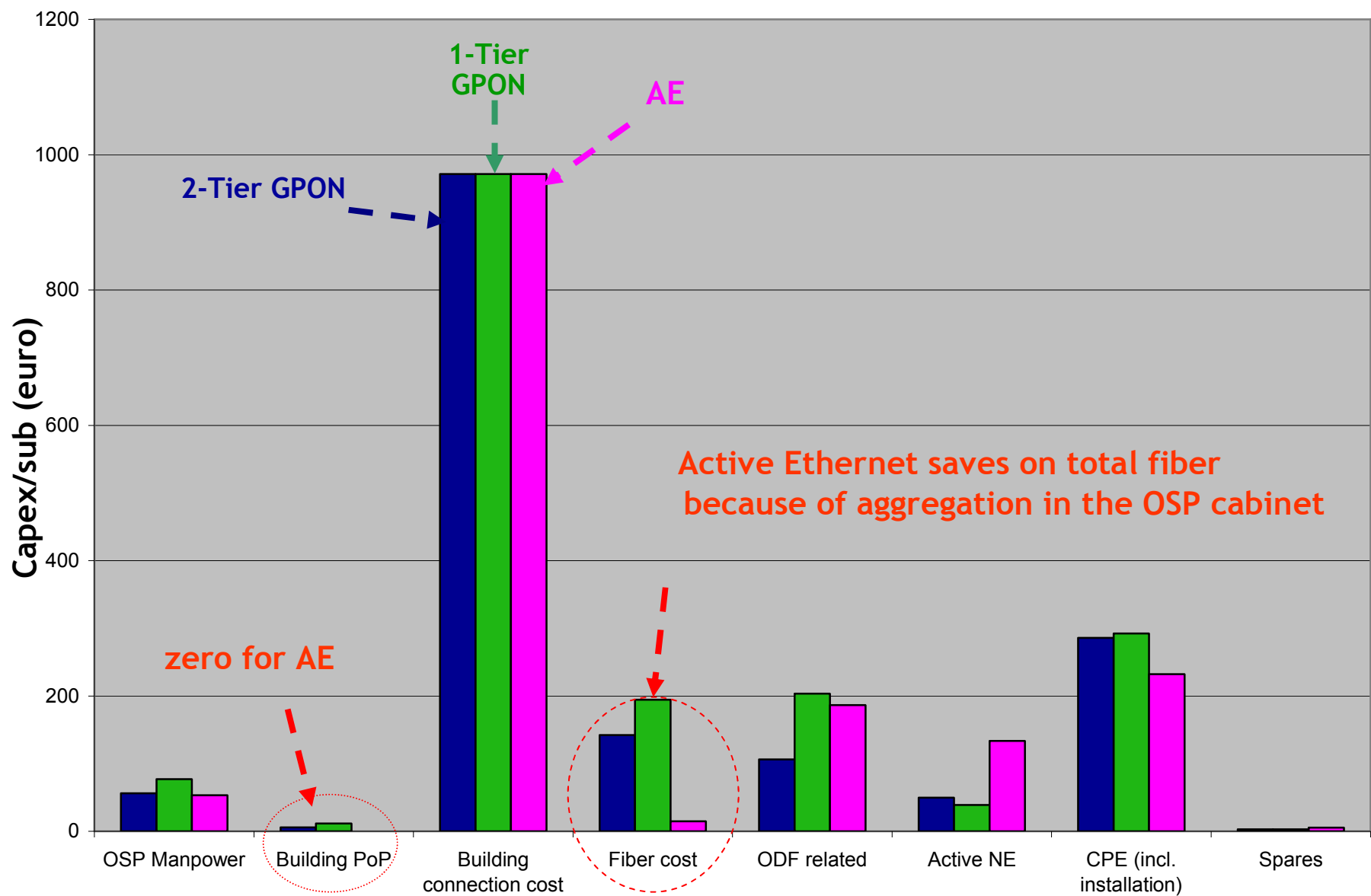
Scenario/Assumptions:

- The operator has deployed DSLAMs to provide ADSL/VDSL broadband access to some end users
- A number of fiber loops can be provisioned to provide FTTH access to users. Which technology is more economical to deploy Ethernet or GPON?
- For Ethernet deployment:
 - Ethernet card can be installed in existing (DSLAM) street cabinets
 - Civil work for distribution network only (cabinet to sub) is included
 - New fiber from cabinet to CO using existing civil work - only new fiber installation
 - 4500 cabinets to cover a dense urban area
 - Two Cases
 - Case 1: Reuse existing DSLAM shelf to install AE cards
 - Case 2: New OSP cabinets for AE – no DSL
- For GPON deployment:
 - Splitters installed in some of the street cabinets and OLT in the COs; 200 FFPs for GPON
 - Civil work and fiber installation in the feeder and distribution network is the same as the greenfield GPON cases

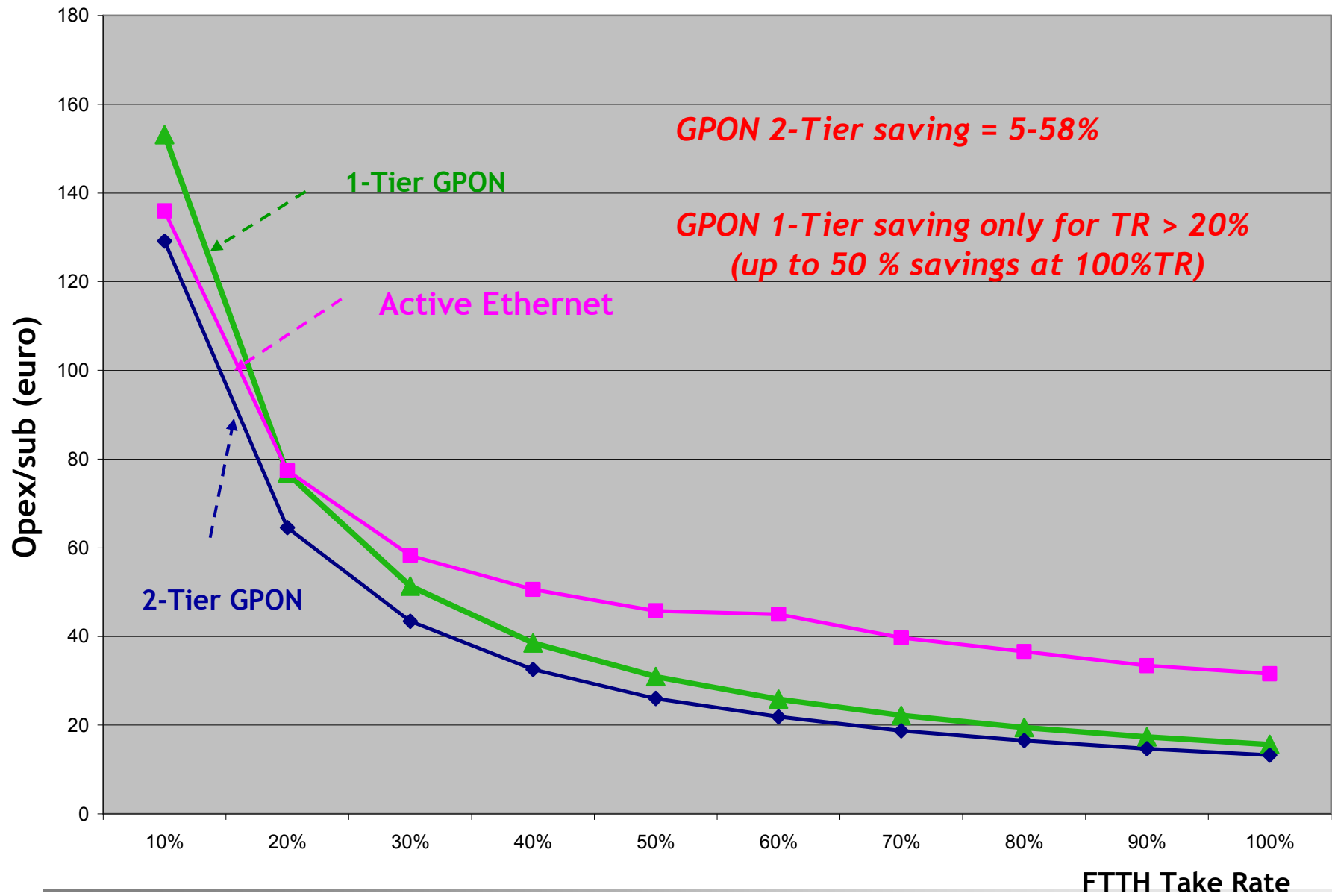
GPON vs AE Case 1: Reuse Existing DSLAM Shelves - Capex/sub



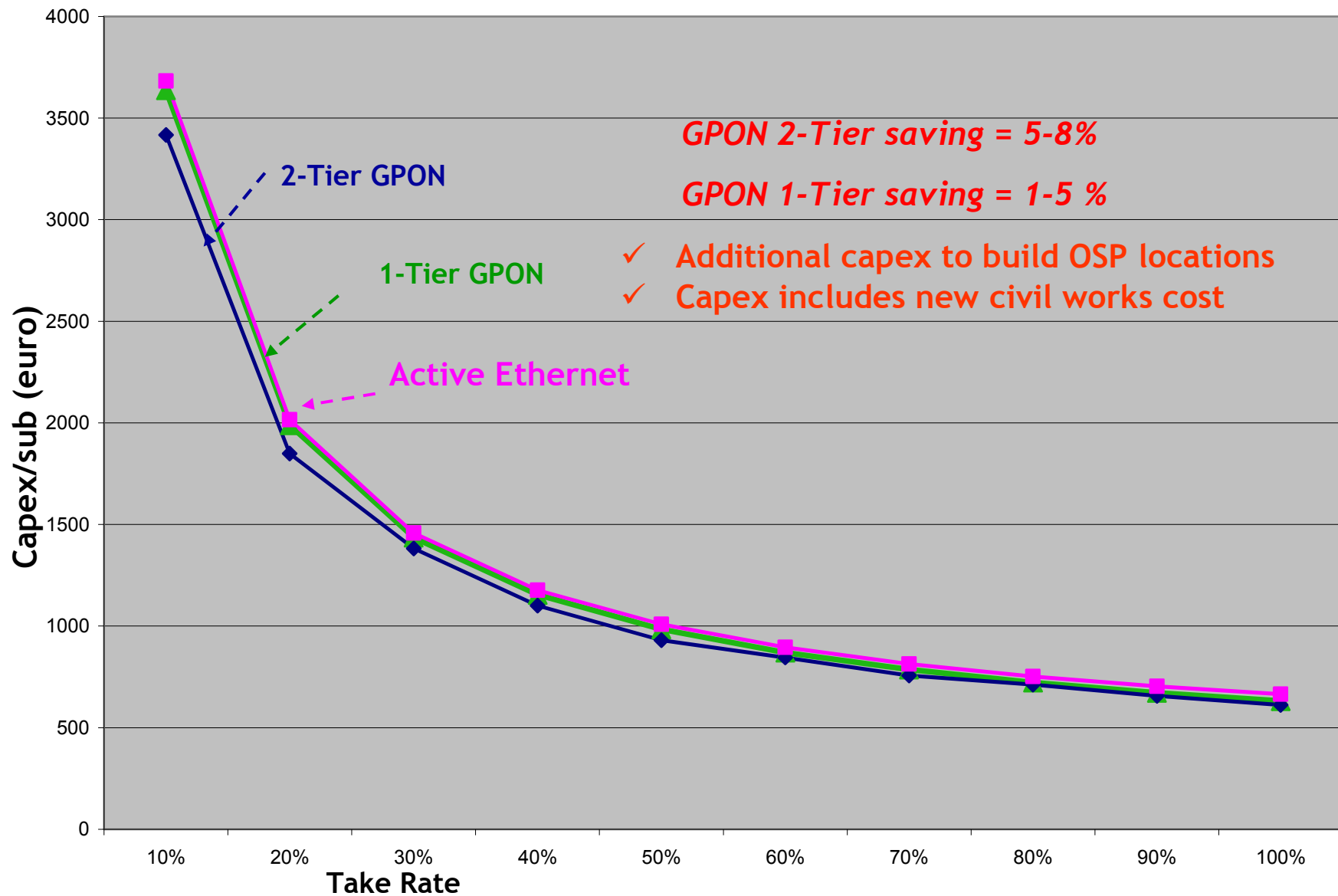
GPON vs AE Case 1: Capex Breakdown, 20% TR



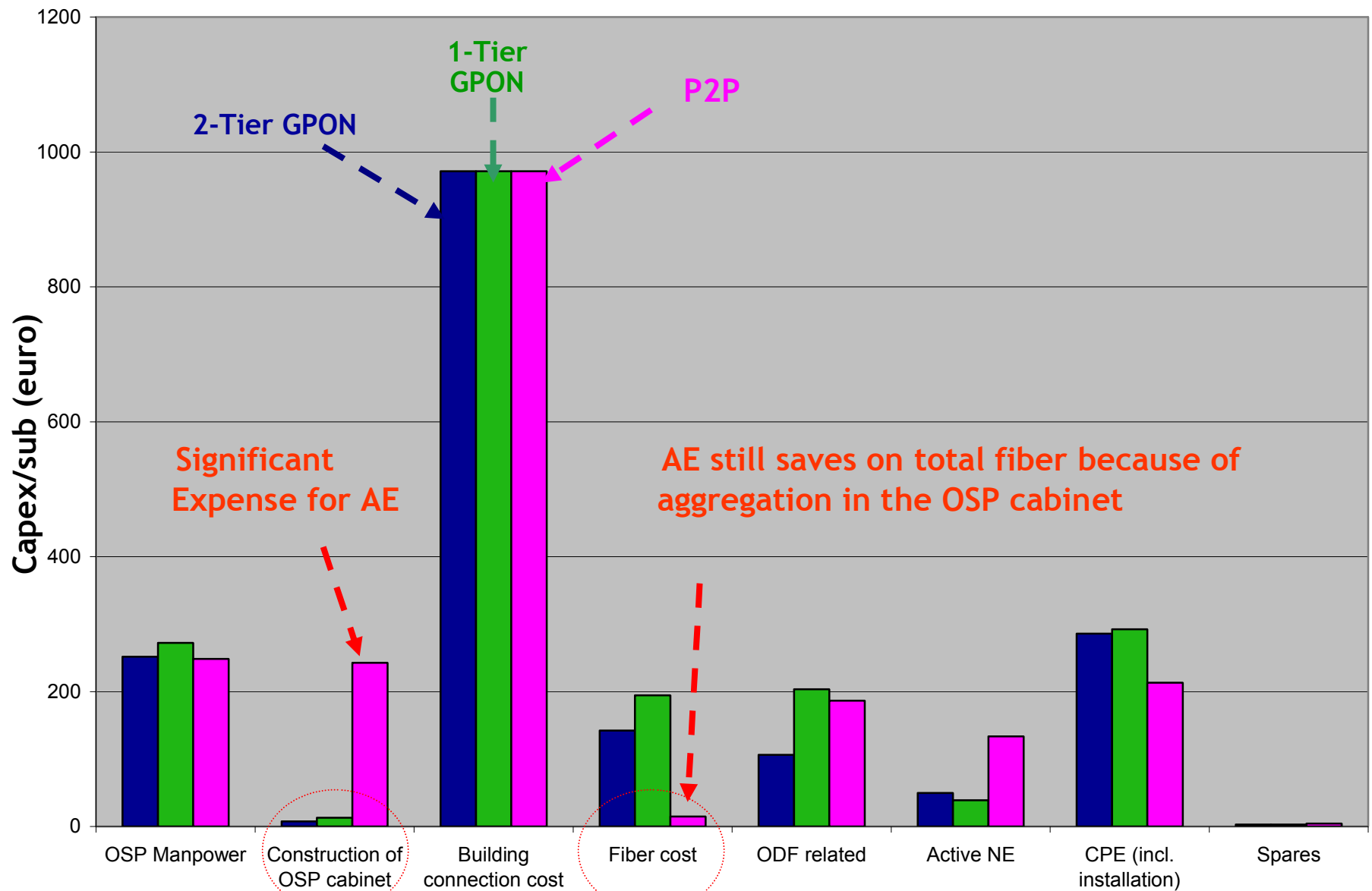
GPON vs AE Case 1: Opex/sub



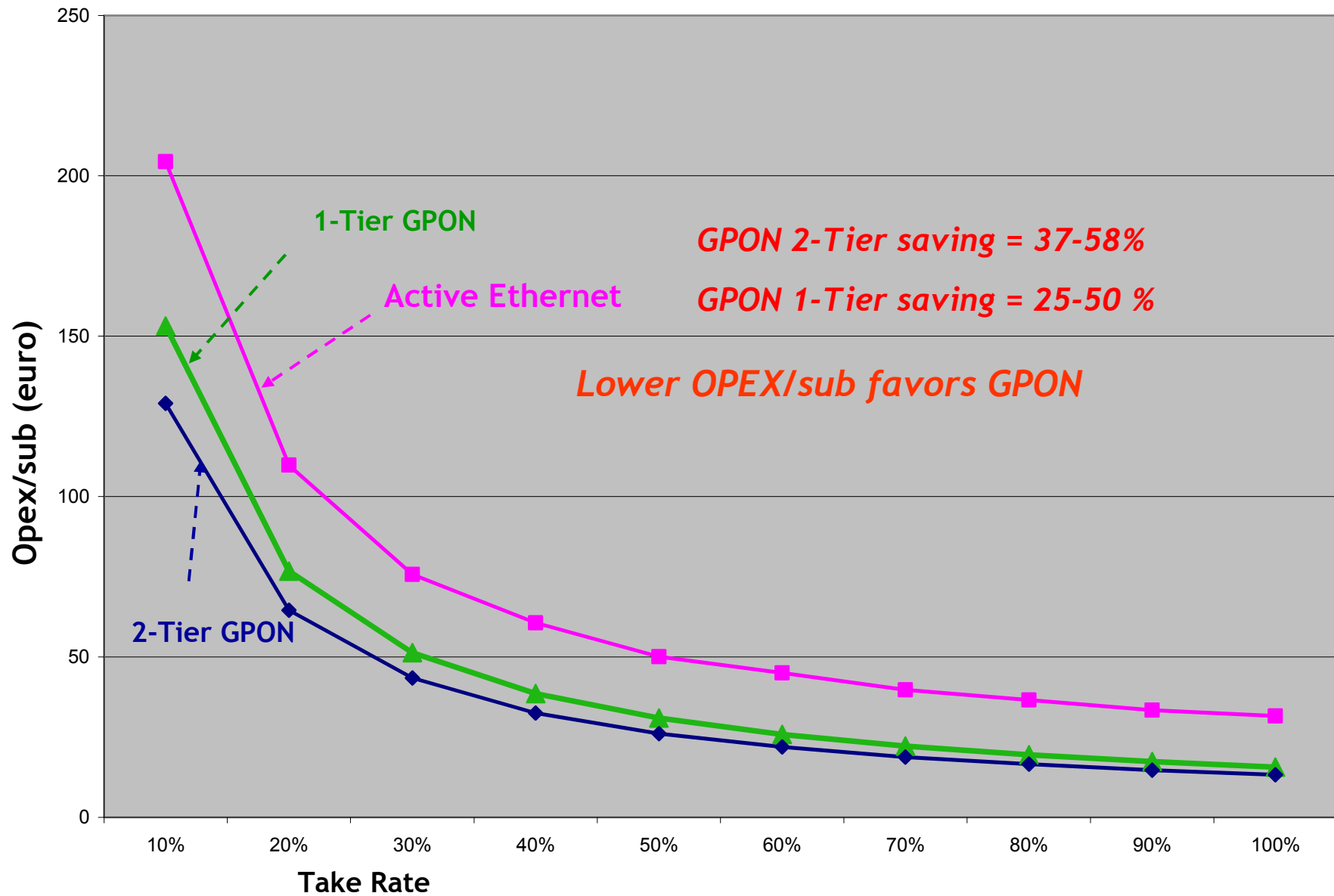
GPON vs AE Case 2: New OSP Locations for FTTH - no DSL - Capex/sub



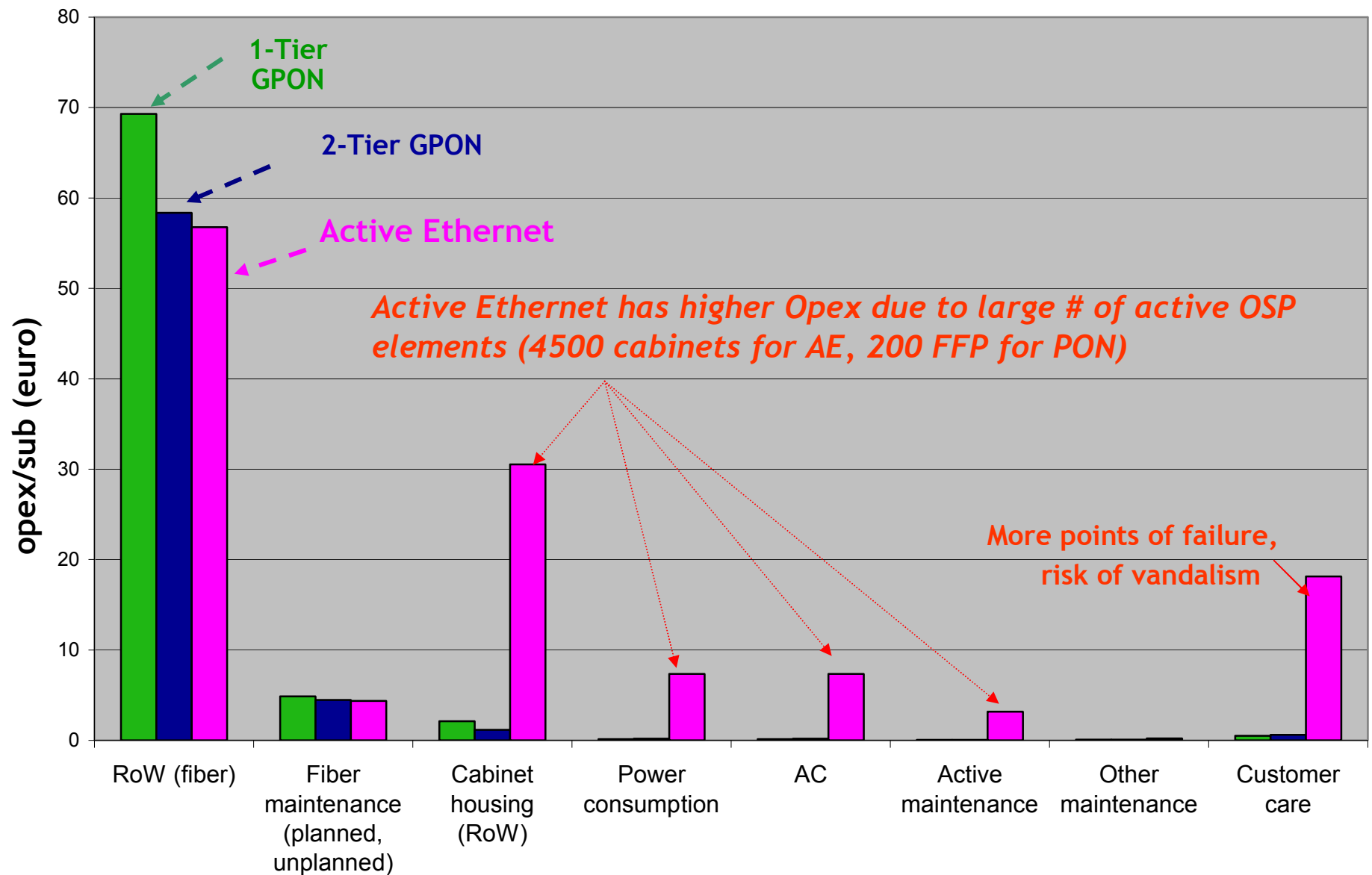
GPON vs AE Case 2: Capex Breakdown



GPON vs AE Case 2: Opex/sub



GPON vs AE Case 2: Opex/sub Breakdown, 20% TR



Summary

Greenfield & Overbuild FTTH deployment:

GPON provides lower Capex and Opex/sub compared to P2P across all take-rates.

- Significant Day 1 OSP investment and higher Right-of-Way (RoW) Opex for P2P
- Average savings: Capex ~ 20% (MDU/SFR); Opex = 55-60% (MDU), 40-45% (SFR)
- 2-Tier GPON cheaper than 1-Tier (for MDU) by 0-10% (function of take rate)

Hybrid Deployment (using DSLAM cabinets):

Overall, GPON and AE Capex are similar, but GPON provides significant OPEX savings

- Small Capex savings for AE vs. GPON (0-5%) in areas with existing DSLAM cabinets. However GPON offers Opex savings of 5-58%
- In areas with no DSLAMs, GPON Capex savings of 5-8%. However, GPON Opex savings are 37-58%

Key sensitivity analysis parameters impacting GPON Capex savings:

- Fiber cost/meter; GPON CPE cost; Ethernet switch cost; remote Ethernet switch housing cost; and GPON OLT cost
- Increased GPON deployment by major carriers should further lower GPON costs

Key sensitivity analysis parameters impacting GPON Opex savings:

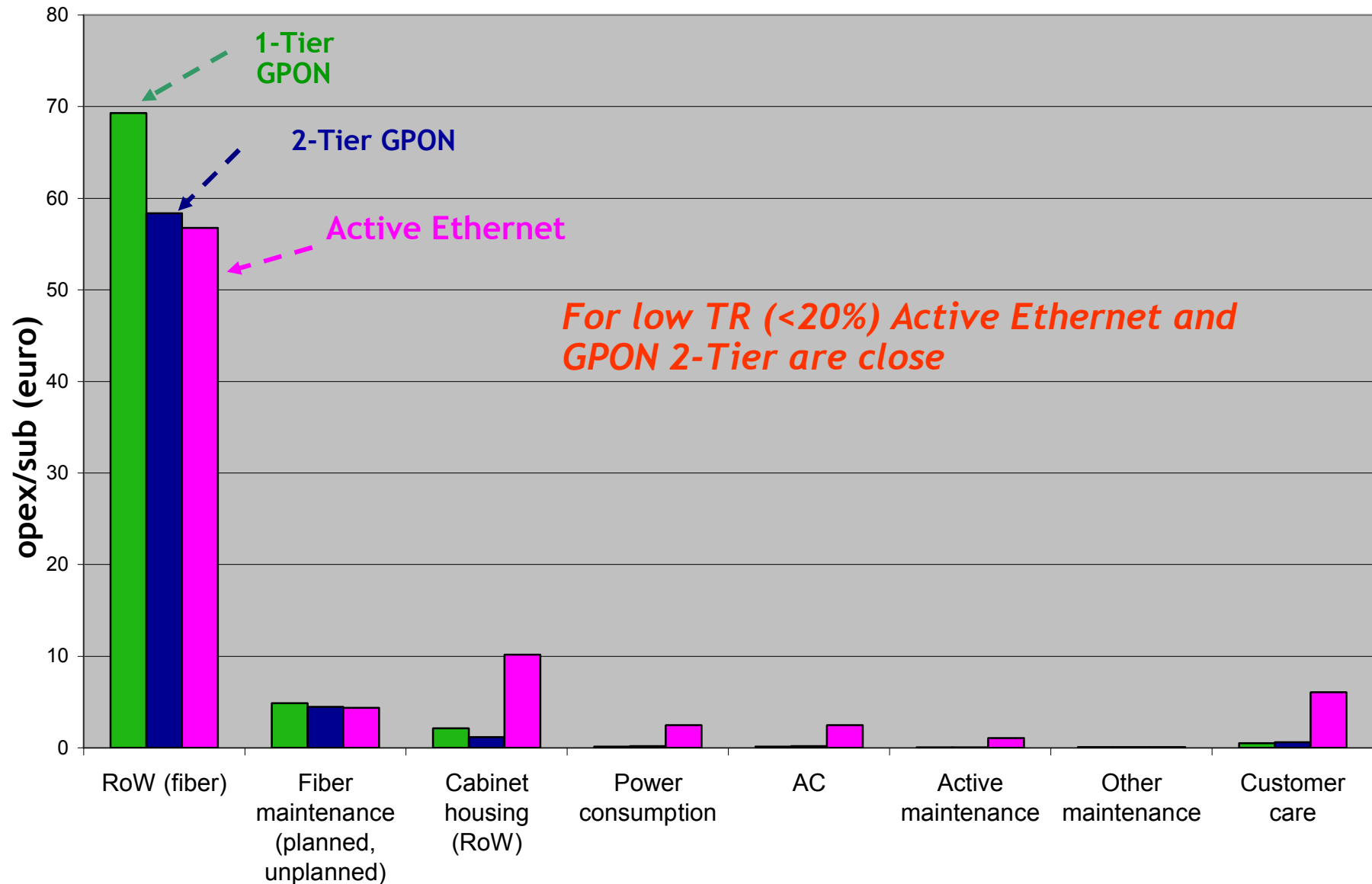
- Right-of-Way; Cost of energy and Fiber maintenance costs
- Energy costs are projected to increase in the future; further increasing GPON savings

Other Comments

- Another study shows that there are some special situations where P2P Capex is similar to GPON for non-large scale deployments (outside scope of this paper)
 - ✓ For a very small # of HHPs (<3K) or small serving area/CO (<1km²) like an island; however such deployments tend to be very small
- Newer, more cost-effect fiber deployment technologies such as micro-trenching will help reduce overall FTTH deployment costs, but will not make P2P cheaper than GPON

BACKUP

GPON vs AE Case 1: Opex/sub Breakdown



Urban MDU: Capex/sub Breakdown (20% TR)

