

## Eco-efficiency in action

### Alcatel-Lucent sustainability solutions for access networks

While the ICT industry is a relatively minor contributor to greenhouse gas emissions, its footprint today is growing. The challenge to the sector as a whole is to reverse this trend — and capitalize on its inherent ability to minimize other sectors' environmental impacts as well. To date, many eco-efficiency efforts have been ad hoc or unfocused. In this paper, Alcatel-Lucent focuses on the access portion of the network, identifying specific instances in which currently available technologies can reduce power consumption and environmental disruption to achieve measurable, meaningful improvements. By employing solutions such as these, the ICT industry stands to fulfill its potential of reducing GHG emissions by 15 percent over the next 10 years.



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## 1. Introduction

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Information and communications technologies (ICTs) contribute a relatively small proportion of the world's total greenhouse gas (GHG) emissions. Yet they present many opportunities to help reduce those emissions, save energy and conserve resources. Much attention has been paid lately to the potential of ICT to reduce energy consumption in businesses and homes by enabling teleworking, telemedicine, smart grids and smart building services. According to the *Smart 2020* report<sup>1</sup>, such ICT contributions could help achieve a 15 percent reduction in total emissions by 2020.

That said, ICT-related GHG production is rising — and could triple over the next decade. The challenge to the industry is to minimize ICT's own GHG contributions while maximizing its capacity to help other sectors reduce theirs as well. This requires both a big-picture, holistic view of the network — a perspective that competitors of Alcatel-Lucent do not typically take today — and also an empirical, well-informed focus on areas of opportunity: where energy savings can be realized and emissions meaningfully reduced.

Up to now, the development of eco-efficient solutions has happened largely ahead of market demand. While people, businesses and governments today recognize the importance of conserving resources, realizing competitive efficiencies and minimizing environmental impact, they are not always clear about where the needs are most acute or which solutions to adopt to realize the greatest benefits.

This strategic white paper identifies three key areas in the access network where emissions are generated today — and suggests focused, technology-based solutions for minimizing those emissions and improving overall access network efficiency.

## 2. Opportunities for efficiency: where change is needed

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ICT's carbon footprint has been misreported in the media as being equivalent to that of the airline industry, an assertion first circulated at the Gartner Symposium/ITxpo in 2007. Comparing the end-to-end impact of ICT (according to a lifecycle analysis) with direct emissions from aircraft engines is misleading and grossly overstates the environmental effects of ICT. A truer figure is that ICT represented, in 2007, roughly two percent of all GHG emissions around the world. By 2020, the sector's GHG output may increase to as much as 1.4 GtCO<sub>2</sub>e (billion tonnes of carbon dioxide equivalent).

ICT's potential to reduce emissions extends across multiple sectors. 'Eco-services' such as teleworking, telemedicine, home assistance for those with special needs and facilitating smart, connected homes (in which heating, appliances, modems, set-top boxes, etc., are always available rather than always on) provide well-documented opportunities to reduce the consumption of non-renewable energy and other resources. The services mitigate environmental consequences such as the greenhouse effect and air acidification. If these services were utilized, a 15 percent reduction in total emissions (7.8 GtCO<sub>2</sub>e) could be achieved by 2020.<sup>2</sup>

Most eco-services depend on broadband connectivity, typically through fiber-deep access networks such as fiber-to-the-node (FTTN), fiber-to-the-building (FTTB) and fiber-to-the-home (FTTH). As will be explained later, this poses a challenge.

When the overall GHG emissions of the ICT sector are broken down, nearly half are associated with devices in the home: personal computers, peripherals, printers and the like. Telecom was responsible for 37 percent of ICT emissions in 2007; data centers for 14 percent. In other words, the devices that enable GHG-reducing travel displacement are themselves sources of GHG emissions, as are the telecommunications networks that deliver them.

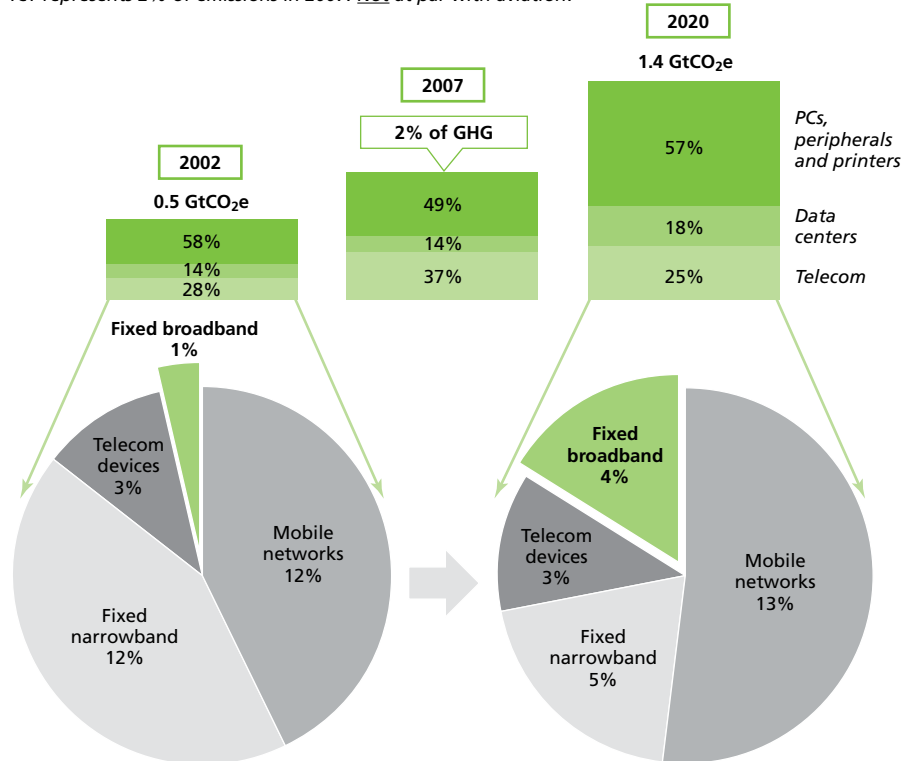
<sup>1</sup> *Smart 2020: Enabling the Low Carbon Economy in the Information Age*, The Climate Group, 2008

<sup>2</sup> *Ibid*

**Figure 1. Reducing GHG emissions**

**Our challenge: Cut greenhouse gas emissions**

*ICT represents 2% of emissions in 2007. Not at par with aviation!*



Source: Alcatel-Lucent analysis of Smart 2020 data

ICT challenge: x3 increase GtCO<sub>2</sub>e from 2002 to 2020

## 2.1 Zeroing in on the access network

The access portion of today’s networks is home to three ‘centers’ of environmental impact: the customer premises, the outside plant (OSP), and the network equipment itself. In each of these areas operators seem open to adopting eco-sustainable solutions — provided those solutions can be shown to strengthen their competitive position, streamline their operations or operating costs, or open up new areas of opportunity. Alcatel-Lucent refers to operationally efficient eco-sustainable solutions as “eco-efficient,” emphasizing the positive correlation between their environmental and financial aspects.

Product life cycle analyses of GPON (gigabit passive optical networking) and VDSL (very high speed digital subscriber line) technologies confirm that the access network’s greatest environmental footprint occurs in the home. An Alcatel-Lucent/RDC environment study found that 82 percent of GPON-related lifecycle eco-impact is attributable to the operational phase of the optical network terminal (ONT) equipment. For VDSL, customer premises equipment (CPE) accounts for 67 percent of the lifecycle eco-impact. These figures signal that more efforts should be made to reduce CPE energy use.

The power consumption of ONT and CPE has relatively little direct effect on a service provider’s operating expenditures (OPEX), while the power consumption of network equipment has a direct impact on OPEX and is therefore important from a service provider’s point of view. Network deployment

is another area where providers feel the direct impact — it is always a costly, disruptive prospect. When fiber is run to a home, some environmental disturbance is unavoidable. Yet the eco-services that are implemented as a direct result of that deployment eventually benefit the environment. According to studies by the FTTH Councils in Europe and Americas, the positive impact of FTTH on ICT emissions should be evident in the U.S. in six years and in the European Union in 15. The difference in the two timescales stems from the fact that buried cable is typically used in the EU, while aerial fiber is most often chosen in the U.S.

## 2.2 What operators are looking for

Network operators will adopt green solutions for their access networks if those solutions can be shown to strengthen their competitive position, streamline their operations or operating costs, or open up new areas of opportunity — and have a positive impact on the environment. This in a nutshell is the essence of an eco-efficient strategy.

In each of the three areas identified above — network equipment, outside plant and CPE — eco-efficient solutions present a compelling business case. Sustainable technologies can, for example, reduce the power consumed to cool Central Offices and the network equipment in them. Given rising energy costs, such reductions would yield material benefit for any operator.

### UNDERSTANDING TOMORROW'S CONSUMERS

In 2008, the Alcatel-Lucent Teen Lab surveyed 64 youth from 19 countries on their attitudes toward companies' environmental performance. More than 70% of participants said a company's environmental attitude was important to them.

The study concluded that 'green' influences the purchasing of today's young people — the generation that will be the purchasers of tomorrow's technology equipment and services.

As mentioned previously, deploying outside plant is time-consuming, expensive and environmentally disruptive. It typically involves digging, trenching and fiber deployment. Any alternative approaches that minimize the effort or the impact of this process would appeal to operators.

Finally, even though CPE energy consumption does not typically have a direct cost for operators, it is likely to be increasingly on the minds of operators' customers. Any solutions that reduce the power requirements of DSL modems, optical network terminations (ONTs), remotes and other in-home technologies will have consumer appeal, with positive effects on brand image and loyalty. Evidence also suggests that end users are willing to pay more for so-called 'green' products. The operators that offer such solutions will make themselves more attractive to current and potential new customers.

### 3. Solutions grounded in technology

Alcatel-Lucent understands the large-scale global benefits as well as the tangible business benefits that can arise from eco-efficiency, such as lower total cost of ownership (TCO) and new revenue opportunities through new services. These benefits are realized by:

- Building smarter, eco-sustainable networks at all layers (from wireline and wireless access to transport to the core) with a framework that encompasses hardware, software, site and sub-level network innovation. The Alcatel-Lucent program includes multivendor professional services that help analyze, assess and upgrade network efficiency, extend product life and manage equipment recycling and disposal.
- Enabling communication applications and services that enrich people's lives in sustainable ways (e.g., smart metering, smart buildings).
- Leveraging Bell Labs' strengths to develop groundbreaking technology that drives significant environmental benefits.

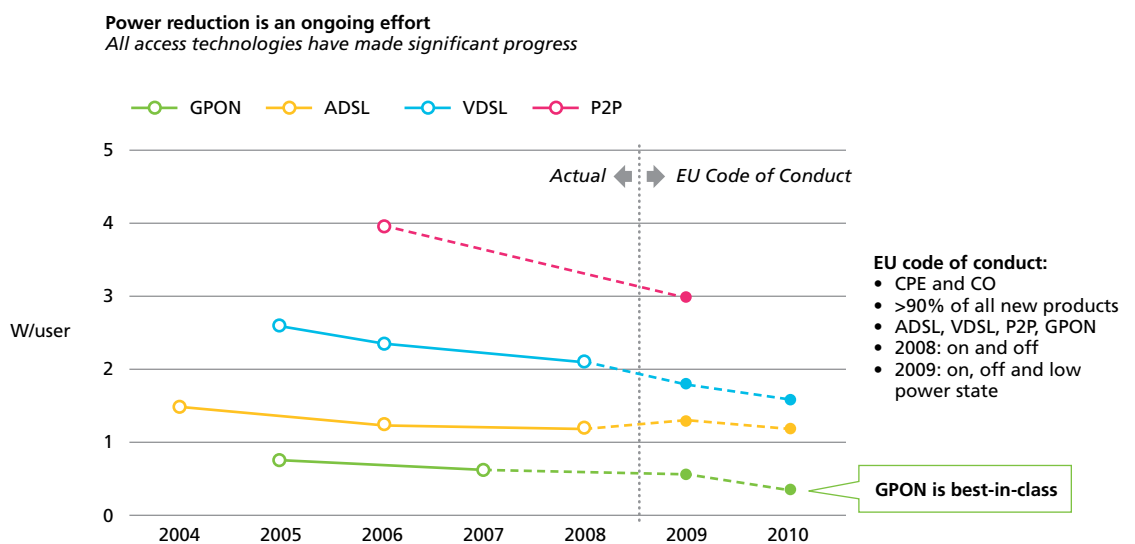
Alcatel-Lucent is committed to introducing eco-efficient solutions that are directly relevant to operators' needs and produce real, demonstrable results.

Drawing on its strengths as an end-to-end solutions provider with years of experience and a legacy of continuous, leading-edge research and development, Alcatel-Lucent has the capacity to bring compelling eco-efficient access technologies to market and command network operators' attention. Specifically, Alcatel-Lucent is deeply experienced in the full range of access network technologies — GPON, VDSL and point-to-point (P2P) FTTH — and in network equipment, OSP deployment, ONT and CPE.

#### 3.1 Access network technologies

The power efficiency of all access technologies has improved in recent years and will continue to do so. Achieved through greater integration of components, the use of system-on-a-chip technologies and more efficient transceivers, GPON, xDSL and P2P have all evolved to comply with the targets of the EU Code of Conduct on Energy Consumption of Broadband Equipment.

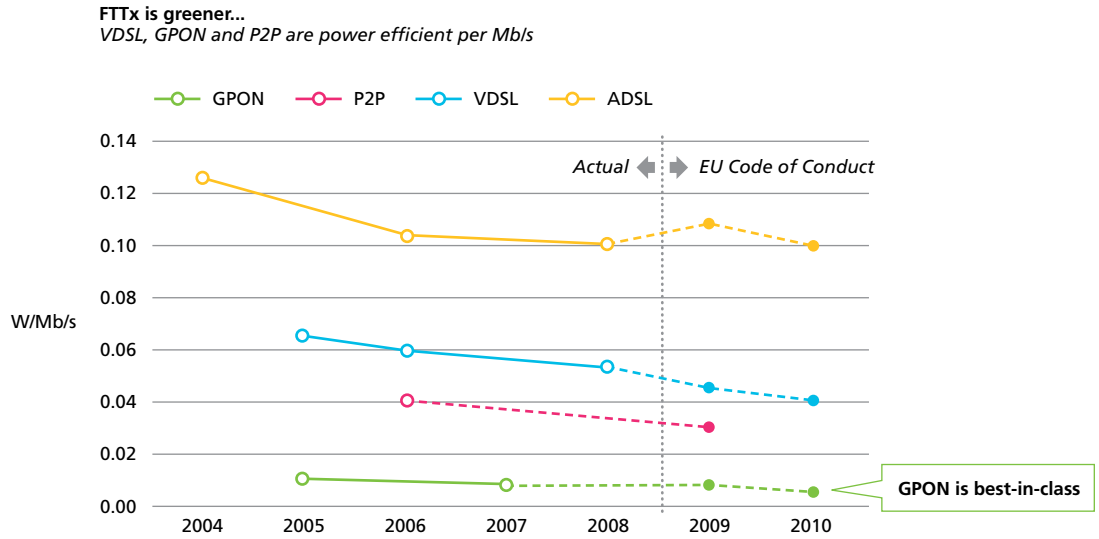
**Figure 2. Access technologies and power consumption**



Power reduction due to higher degree of integration, system-on-chip technology and more efficient transceivers

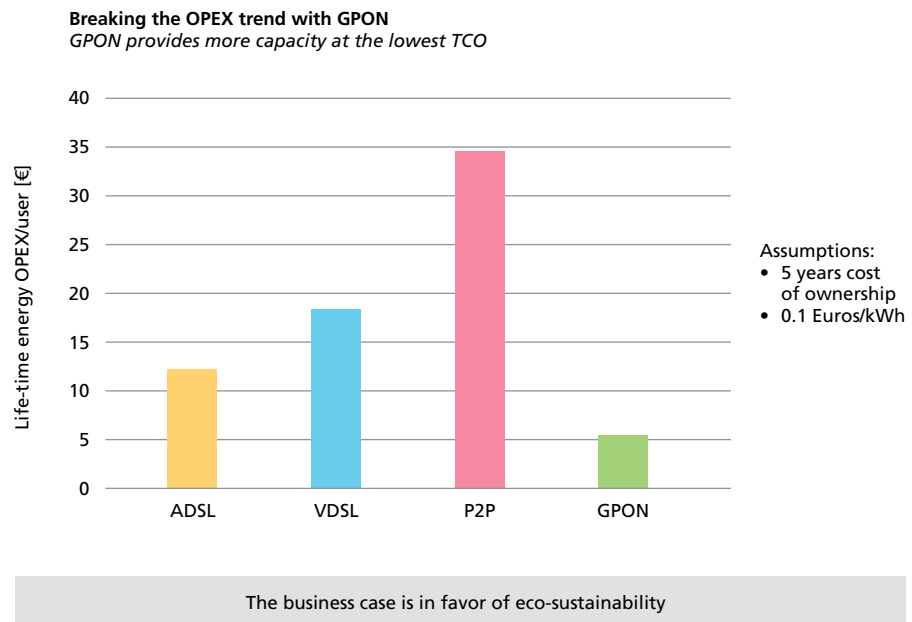


**Figure 3. The most eco-efficient access technologies**



GPON and ADSL are the most power-efficient access network technologies per user, as seen in Figure 2. The picture changes for copper access if one considers power consumption per Mbps in favor of VDSL2, as seen in Figure 3. No matter which metric is being considered, GPON is clearly the most eco-efficient access technology, delivering the greatest capacity, at the lowest total cost of ownership (TCO). Detailed analysis of lifetime energy OPEX for FTTH in a typical European country reveals that GPON eco-efficiency savings are close to 30€ per customer over five years compared to P2P fiber. Alcatel-Lucent has the capability to deliver any of these access technologies to customers.

**Figure 4. OPEX and GPON**



### **Green DSL technologies: A unique Alcatel-Lucent innovation**

As the DSL leader, Alcatel-Lucent is continuously improving DSL technology, including its power consumption. For DSL, two technologies exist and have been standardized: the L2 low power mode for ADSL2/ADSL2plus, and MaxSNRM (maximum signal-to-noise ratio margin) for ADSLx and VDSL2 (Note: L2 for VDSL2 is not yet defined). The concept is simple: L2 power mode switches a line to a lower bitrate and power level when user activity drops below a certain threshold, while MaxSNRM caps the noise margin (by reducing power) when it exceeds a certain threshold.

These two technologies have existed for some time but have not been widely deployed until now, as power fluctuations can generate varying crosstalk, which in turn can make the network unstable. In combination with its Smart DSL technology — designed to stabilize lines affected by crosstalk — Alcatel-Lucent is able to offer the first stabilized and deployable L2/MaxSNRM end-to-end solution on the market. The solution combines ISAM family DSLAMs with selected CellPipe CPEs and realizes power savings of up to 25 percent.

As well, Alcatel-Lucent has also been working on new generation line cards based on eco-efficient technology. These yield power savings of up to 10 percent for VDSL2 and up to 20 percent for Multi-ADSL compared to previous-generation line cards.

#### **3.1.2 Distributed DSLAM: Another unique eco-efficient concept**

This Alcatel-Lucent innovation minimizes power consumption in fiber-to-the-node deployments, achieving as much as a 24 times reduction in the overall number of nodes to manage. With no dedicated controller per node and one central network terminal for 24 REMs/SEMs, the distributed DSLAM concept reduces power consumption as well as OPEX and operators' capital expenditures (CAPEX).

Comparing distributed DSLAM to a traditional standalone remote DSLAM scenario, assuming 48p nodes and a six-year period, the distributed alternative saves as much as 60 percent in aggregation CAPEX, 40 percent in OPEX, and up to 20 percent in power consumption.

#### **3.1.3 Power efficient optimized platforms for DSL and GPON**

A converged platform for both DSL and GPON may seem attractive at first glance. A closer look, however, reveals a number of technical, operational, economical and environmental concerns. It is important to distinguish between hardware and software convergence. The latter, which is fully supported by Alcatel-Lucent's ISAM family, is crucial to maintaining a consistent, end-to-end service delivery architecture over both fiber and copper and streamlining operational costs. Operational issues associated with common hardware for DSL and GPON make this option less attractive for many deployments. Most importantly, converged DSL/PON hardware platforms often fail to address the following key issues:

- *Different deployment models* – VDSL and P2P systems are typically deployed close to the subscriber in the OSP while GPON systems are most often deployed in the CO or 'super CO'.
- *CAPEX inefficiencies* – deploying an expensive high-capacity PON platform for a limited number of DSL subscribers results in very high prices per line.
- *Cabling constraints* – full DSL/PON flexibility requires full copper/fiber cabling to each shelf, which is an operational challenge that requires carefully planned racks and cabinets.
- *Eco-inefficiency* – using a high-capacity PON platform for DSL typically results in power inefficiencies due to over-dimensioning of the switch matrix and excessive interworking functions required to support both DSL and GPON. Detailed analysis shows that a DSL optimized platform consumes between 10-15 percent less power than a converged platform.

### 3.2 Focus on the outside plant

According to a lifecycle analysis of FTTH conducted by the FTTH Council Europe, some 83 percent of network-related CO<sub>2</sub> emissions result from the deployment of passive fiber. As mentioned previously, digging trenches and laying fiber is disruptive, expensive, and carbon and energy intensive. Alcatel-Lucent is a strong proponent of duct sharing and microtrenching to reduce all of these impacts.

#### 3.2.1 Cabinets with heat exchangers

Maintaining proper temperature control of network equipment is essential to optimal performance, yet traditional air conditioning is expensive and environmentally taxing. Heat exchange and direct air cooling are more eco-efficient than air conditioning, and both are used in outdoor cabinet solutions according to customer requirements and environmental conditions. Direct air cooling is the most eco-efficient option, yet requires more maintenance (dust filters must be changed on a regular basis, requiring a site visit by a vehicle — which does add to the carbon footprint). Heat exchange technology provides a versatile and efficient alternative and, because of its use of variable-speed fans, more refined power consumption — though it typically requires the enclosed equipment to be capable of a wider operating temperature range than when cooled by air conditioning. Overall, using a heat exchanger instead of a conventional air conditioner can save roughly 20 percent in power. This technology further strengthens the Alcatel-Lucent offering, which in many cases does not typically require air conditioning due to the hardening of the equipment by design (many Alcatel-Lucent network products can withstand temperatures of up to 65 degrees Celsius).

#### 3.2.2 Duct sharing

Duct sharing minimizes the civil work required for fiber deployment and lowers the CAPEX barrier to new rollouts because multiple operators share the cost of deployment. This accelerates time to market for new service delivery while stimulating infrastructure-based competition. In an Alcatel-Lucent case study of a dense urban area with multi-dwelling units (MDUs) of 20 apartments, duct sharing reduced the FTTH costs of fiber deployment by 15 percent and the FTTB costs of copper deployment by the same amount. By reusing existing infrastructure, environmental impact can be reduced by up to 40 percent depending on the number of ducts or sewers that are shared among different service providers.

#### 3.2.3 Microtrenching

Microtrenching is the process of making small, 'surgical' incisions in the ground to lay fiber. As well as being eco-friendly, it is also aesthetically preferable for the urban or suburban landscape. Because of its precision and minimized scale, microtrenching cuts deployment costs by roughly 30 percent and deployment time by 70 percent, according to TeraSpan — a company with which Alcatel-Lucent has a strategic microtrenching partnership. In dollar figures, a study conducted in Winnipeg, Canada found that microtrenching saved approximately \$800,000 for every 10 miles.

**Figure 5. The advantages of micro-trenching**

**OSP: Dig smart!**

*Micro trenching is fast, cheap and aesthetic*



Micro trenching provides 70% saving in labor.

### **3.3 Crossing the threshold: customer premises equipment**

Alcatel-Lucent advocates for service providers to address the carbon footprint of the CPE portion of the access network by using passively cooled remotes and taking advantage of power enhancements in deployed technologies.

#### **3.3.1 Eco-efficient GPON ONTs**

At the start of 2009, Alcatel-Lucent launched a new set of lower power dissipation GPON ONTs. These consume up to 30 percent less power than previous generation ONTs and are compliant with the European Code of Conduct for the period in which it has been defined (2011). Apart from being eco-efficient, this new line of ONTs comes with hardware support for residential gateway functionality, permits remote optical performance monitoring, and has Gigabit Ethernet wirespeed throughput.

#### **3.3.2 Passively cooled remotes**

Passively cooled remote DSLAMs typically consume 10 percent less power than their fan-cooled counterparts. They have the added benefit of being quick to deploy and are noise free. Alcatel-Lucent's ISAM FTTB portfolio includes passively cooled VDSL2 remote DSLAMs for both GPON and P2P.

### **3.4 A truly eco-efficient approach**

By rigorously identifying needs areas for energy efficiency, cost savings and GHG reductions in the access network, Alcatel-Lucent has developed solutions that are focused, targeted and capable of delivering meaningful, measurable results. The solutions advanced here for the network, OSP and CPE are available to customers today, yield demonstrable benefits and, in the case of eco-efficient DSL and distributed DSLAM, represent genuine innovations in the access network arena. They consider the whole picture associated with eco-efficient solutions — and are designed to realize environmental, social and business benefits.



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