# Energy consumption trends in the Next Generation Access Network - a Telco perspective

Claudio BIANCO, Flavio CUCCHIETTI, Gianluca GRIFFA
TELECOM ITALIA – Technology-Innovation& Engineering
Via Guglielmo Reiss Romoli, 274 - 10142 Torino, ITALY
[ claudio1.bianco@telecomitalia.it; flavio.cucchietti@telecomitalia.it; gianluca.griffa@telecomitalia.it ]

**Abstract - The paper will provide an analysis on the trend of energy consumption for the Next Generation Access Network, taking into account VDSL2 deployment in FTTx architectures. It points out the related issues and needs for a Telco as Telecom Italia, which aims to manage the energy consumption evolution in a sustainable way.**

**The analysis will give evidence of the growing energy consumption trend that can only be faced by a strong and coordinated action between Regulators, Operators and Industries, aiming to the optimization (reduction) of energy consumption (e.g. through standardization activities).**

**The parallel constantly growing cost of electrical energy could lead to unacceptable energy budgets for Telcos, together with a strong negative impact on eco sustainability. The initiative of "Code of Conduct on energy consumption reduction of BB equipment" issued by the European Commission will be quoted and details will be provided.**

**The paper will also focus on further aspects for a sustainable deployment of active equipment in the access network for FTTx architecture, such as need of new standardized environmental classes for active equipment to be hosted in outdoor cabinets, need of action on the mechanical aspects to have a reduction of the needed space, possible back-up sources for availability of service (life-line service). These issues, together with the energy consumption minimization, are the key factors for a successful and sustainable deployment of FTTx architecture.**

**The paper will, in its final section, propose a focus on possible alternative and renewable energy sources for Telecommunications application: Telecom Italia is analyzing possible alternative energy sources to be adopted in the power feeding in its network, matching a national energy policy scenario leading to deeper attention to energy savings and usage of alternative energy sources.**

## I. ENERGY CONSUMPTION WITHIN TELECOM ITALIA FIXED NETWORK: THE PAST, THE PRESENT AND THE FUTURE

Today, the electrical energy needed by the Telecom Italia's Network is more than 2.000.000.000.000Wh (> 2TWh), representing nearly 1% of the total National energy demand, second user only to the National Railways. As the cost of energy is continuously and strongly increasing, the related OPEX is becoming more and more relevant with growing impact on the overall company's financial results.

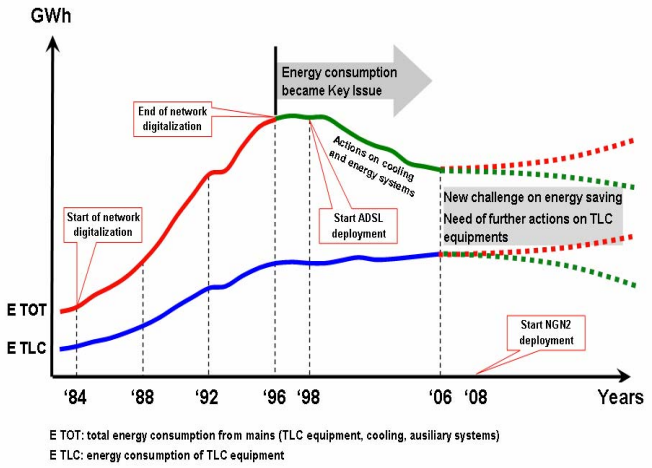


Figure 1: electrical energy consumption evolution end future trends for TI's fixed network

Figure 1 shows an historical analysis of electrical energy consumption evolution, with focus on the fixed part of the Telecom Italia's network, from the early '80s up today and depicts possible future scenarios of energy consumption trends for next years. This part represents roughly 80% of the total Telecom Italia S.p.A. network consumption.

During the '80s and '90s the network changed from analogical-electromechanical to a full digital switching, this change had a strong impact on the network's energy consumption in terms of its growth.

In the last years, further increase of the TLC load was caused by the gradual introduction of new equipment in order to deliver the xDSL services. The Broadband platform has been deployed in parallel with the Narrowband platform (POTS and ISDN). This resulted increase of total TLC load was balanced only by strong efficiency improvements on the powering and conditioning systems in the CO.

Main actions taken have been:

- rise of the maximum temperature acceptable within an equipment room
- replacement of energy stations with lower conversion yield;
- broad adoption of free cooling;

– replacement, rationalisation and optimisation of air conditioning plants;
– compacting PSTN Switching modules;
– switch-off of obsolete equipment.

Telecom Italia is also aiming to reach additional energy efficiency trough further fixed-mobile integration, simplification/ modernization, OSS integration, working space optimization and Organization evolution/rationalization.

But if a deep change of TLC network has undergone during the last years, a new and more important evolution (or revolution) of the network (and specifically of its access part) if foreseen in the nearby future, with the start of NGN's deployment, this implying new challenges on energy savings.

Concerning the evolution of Network Architectures towards the fully BroadBand Next Generation Network (NGN2) , the Group defined the evolution path that will lead in the next few years to the introduction in the Telecom Italia network of innovative architectures based on FTTB (Fiber to-the-Building) and FTTCab (Fiber to-the-Cabinet) technologies.

## II. Next Generation Access Network

The market and services evolution to enable triple and quadruple play requires a complete renewal of the telecommunications networks. To this end, the Access Network will play a major role both enabling higher speeds and being future proof. This can only be achieved trough the progressive optical fibre deployment in FTTCab, FTTB (and in the longer term FTTH, see fig. 2) architectures that will progressively shorten the copper access network, boosting the performances of the xDSL systems (see fig. 3 and 4).

BroadBand penetration and bandwidth demand is continuously growing, requiring therefore more and more energy. The new transmission technologies, like VDSL2, allow higher and higher speeds with consequent increased complexity and power consumption.

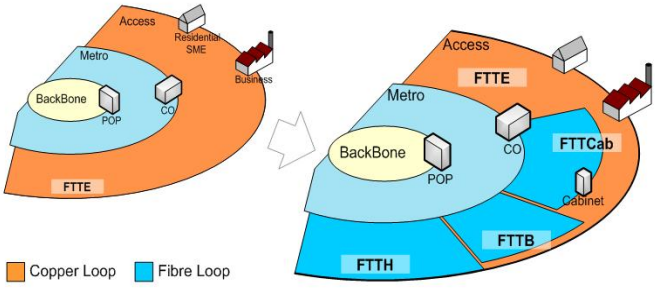


Figure 2: Network topology evolution with NGN2

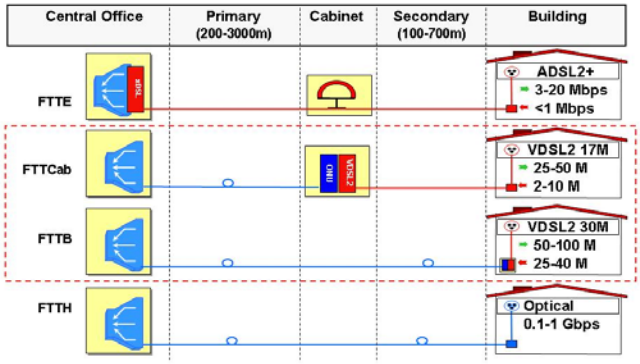


Figure 3: access architecture and performance for NGN2 (source: TI)

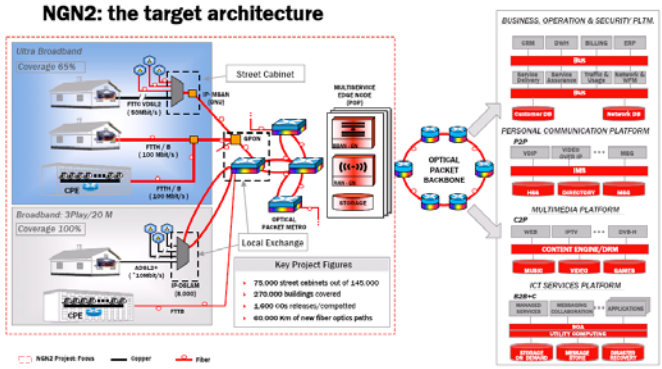


Figure 4: Telecom Italia's NGN2 target architecture

Therefore, a new network paradigm of discontinuity is expected: the network will move from thousands Central Offices with medium/high electrical load to >100.000 of distributed systems in the access network due to the new topology of NGN2.

Considering that VDSL2 technology can transmit about 5 times more bits/s than ADSL2+, but requires at least double the energy to operate (and even higher speeds/complexities are on the way) two main challenges arise:

- power dissipation issues: strong focus needs to be kept on this aspect as an excessive power dissipation can represent a strong barrier towards the technical feasibility of such scenarios
- power consumption: it could lead to an unacceptable growth of the energy budget and the related OPEX, worsened by the increasing trend of the energy cost (it more than doubled in the last 5 years and is expected to maintain the same rate in the future - fig. 5). Therefore this aspect can represent a strong barrier towards the economical viability of such scenarios.

Concerning the last point it must be underlined that the choice of the network architecture has a major impact on the future energy demand of the Operator. To this end the NGN2 target architecture is focused on the sole BroadBand service. It is based on a "Total Replacement" paradigm who will allow

to use just a single BB network interface for each customer instead of the couple NarrowBand/BroadBand required in an "Overlay" scenario.

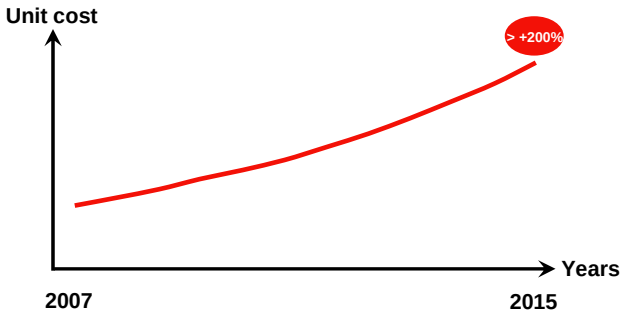


Figure 5: Expected electrical energy's unitary cost trend

A growth in energy consumption will mean also strong negative impact on Telco's eco sustainability: the requests from European Commission, Governments and Stakeholders on environmental protection and sustainable development add extra urgency on such actions.

## III. Climate Change and Environmental Responsibility

In the context of the climate change debate, businesses in many parts of the world are looking more closely at ways of improving their resource and energy efficiency, while approaching greenhouse gas emissions with greater care and examining the emerging markets for emissions trading and carbon-offsetting projects [1].

The need to reduce CO2 emissions arises from scientific evidence supporting the cause/effect link between greenhouse gas emissions and climate change. Telecom Italia Group is committed to reduce its emissions and both encourages and supports the dematerialization of assets and services.

Due to the exhaustibility of fossil fuels and their negative impact on environment, energy saving and alternative source studies are issues of burning topicality.

## IV. Sustainability in Telecom Italia

Telecom Italia Group firmly holds the belief that business activities must take into account and respect the legitimate expectations of all stakeholders, in line with its commitment to the UN Global Compact's Principles. A business should care for its economical results without ever losing sight of the social and environmental context in which it dwells.

Within Telecom Italia, sustainability is measured by a set of key performance indicators (KPIs) structured according to each stakeholder, it is grounded on a system of principles and policies, and it is part of the Group's planning and reporting processes. The Annual Report has a specific Sustainability section, thus confirming the Group's desire to present its financial data together with its non financial performance [2].

The vocation of Telecom Italia to operate in the hi-technology telecommunications industry blends with the awareness of the fundamental service that the Group provides in the economic and social development of all the countries in which it operates. This awareness is closely tied with the firm belief that TI's business activities have to be carried out taking into account the stakeholder's expectations, in line with internationally accredited Sustainability standards.

In defining and implementing Sustainability strategies and programs, the Telecom Italia Group refers to the guidelines issued by the most important world organisations for strategy and standardisation on Corporate Responsibility, particularly by UN Agencies and Programs for Environment and Human Rights and by OECD (Organisation for Economic Co-operation and Development). Telecom Italia adhered in 2002 to the Global Compact (GC) initiative of United Nations, the most important initiative at world level to promote environment conservation, respect of human rights and labour standards, and anti-corruption practices. Telecom Italia Group has committed itself for energy consumption control and reduction, also through Sustainability Indexes (DJSI, FTS4GOOD) and ETNO Sustainability Charter.

In 2006 the Group has been confirmed in the main sector stock indexes, both at national and international level; the qualitative targets set for 2006 with regard to the environment were reached, while quantitative targets relative to Customers, Human Resources, The Environment and Digital Divide have been defined for 2007; two corporate policies have been developed, one related to the safeguard of working conditions and human rights for all the Group's subsidiaries in Italy and abroad, and the other related to the safeguard of the values on which the Group's Code of Ethics hinges, in supplier relations.

In 2007 TI has again promoted important national and international initiatives in line with the commitments undertaken with regard to Sustainability, including the attention to the level of emissions responsible for the greenhouse effect. A special support is given to the "Alliance" launched by the European Commission in 2006, in order to make Europe a pole of excellence in the field of Corporate Social Responsibility [3].

The Sustainability strategy of TI takes also into account the integration between Sustainability and Innovation: a specific section has been devoted to Corporate Responsibility within the Technological Plan, i.e. the document in which the company defines its strategy in terms of technological evolution. The TLC Italian market is considered among the most advanced, both from the technological viewpoint and evolution of customer attitudes as well as customer consumption profiles. To Telecom Italia Group technological innovation is, therefore, an essential and differentiating element in order to develop a competitive advantage and maintain leadership in an increasingly competitive market.

## V. Energy Consumption Reduction trough standardization: European Commission's CoC, ETSI, ITU-T and ETNO

A strong and coordinated action among operators, system vendors and chipset manufacturers is vital to obtain the reduction of power consumption and dissipation for the equipment of NGN2. Standardization activities represent the basic action to reach the scope. Otherwise the inertial trend will lead to an unacceptable boost on the energy consumption of the future network.

In the past years, the standardization activity on the BroadBand access has been deeply focused on the study and specification of more and more complex and fast DSL systems (HDSL, SHDSL, ADSL, ADSL2, ADSL2+, VDSL, VDSL2) and, as requested by the market, main goals have been performances and interoperability.

In the meantime power reductions were achieved, but they were normally related to general technological/production improvements and not to global "energy saving" designs.

European Commission studies (see [4]) foresee that by year 2015, in absence of strong and direct action, the energy consumption of the BB equipment could sum up to 50TWh, contributing significantly to the overall European energy budget. In line with the EU energy and environmental policies the EC took action trough the preparation of a Code of Conduct (CoC) on energy consumption reduction of new BB equipments.

*European Commission's Code of Conduct on BB equipment*

Power consumption reduction is a priority for the European Commission, especially for those sectors with a high development rate (e.g. BroadBand). Since specific norm is lacking, EU has promoted, through its Joint Research Centre (JRC), a set of Code of Conduct (CoC) in order to minimize the consumption of BB, Data Center, STB, CPE equipment.

The Code of Conduct (CoC) for "Energy consumption reduction on new BB equipment" [4] is a voluntary base initiative and is aiming "to target reduced energy consumption of broadband communication equipment without hampering the fast technological developments and the service provided".

It has been promoted from the European Commission-JRC, with the participation of different stakeholders: TELCOs, System Vendors, Chipset Vendors, National Regulators, European Commission. CoC on BB equipment aims to both Network and Customer equipments, requiring power reduction and adoption of power management (Low Power Modes) for new systems.

The requirements on power reduction are pushing for specific study and development of "energy efficient" equipment while the implementation of power management would allow to take benefit from the time periods when the data traffic is limited or absent.

The CoC has been firstly issued in July 2006, and entered into force on 1.1.2007 (tier 1), and will be followed by two more tiers, lasting one year each and who will set more and more strict targets.

The power consumption targets are challenging (see Table I): the 2008 goals are expected to imply an optimization of the system design, while the 2009 targets could be reached through the use of new optimized xDSL chips and a complete redesign of systems, involving therefore the complete manufacturing chain. The development of "power management" mechanisms will, furthermore, need deep analysis and proposal in the standardization bodies but the potential benefit is huge and can justify the big investments needed to study, develop and to test such systems.

Table I

CoC on BB equipment's power consumption targets (operating mode)

| Equipment | Tier 1 (01.01.07) | Tier 2 (01.01.08) | Tier 3 (01.01.2009) |
|---|---|---|---|
| ADSL 2+ | 1,5 W | 1,4W | 1,2 W |
| VDSL2 | 2,75 W | 2,0W | 1,6 W |

Note: the values of Table I are related to fully equipped DSLAMs with more than 100 lines

Aiming at the CoC targets is an unavoidable condition to enable a progressive reduction of the energy drawn by the Network Operator.

It must be pointed out that the CoC on energy consumption reduction of new BB equipment takes into account also equipment at the customer side (e.g. CPE). Lots of BroadBand related appliances/gadgets already populate our homes and many more will come (see fig. 6).


Figure 6: BB equipment on the customer side

User equipment's consumption will be even higher that of the Telecom Network part: customers have to be made aware on the energy behaviour of the systems they are buying as it can have serious impact on their energy bill.

Adhesion to CoC is voluntary and is also promoted by the European TLC Network Operators (ETNO) as it implies to undertake engagements in line with ETNO Sustainability Charter and ETNO Energy Policy.

*ETSI and ITU-T*

ETSI and ITU-T are the technical bodies responsible for the study and definition of the xDSL reference specifications. A proposal to start standardization activities on power consumption reduction of DSL equipment has been presented with wide support from Operators, and accepted (ETSI TM6 and ITU-T SG15). Study points have been set up on all the items defined in the CoC.

ETSI EE (Environmental Engineering) group is working on "system level" energy saving requirements and also a proposal has been presented to standardize new, wider operating temperature ranges for equipment for outdoor installation, to avoid the need of expensive temperature controlling devices at the cabinet such as air conditioners or heath exchangers.

The most critical issue is the "power management" as doubts still exists that the use of such modes could affect the quality of the service. Deep analysis will be needed both from Operators and from Industries.

Quick and successful result will be possible only trough strong commitment and activity from Regulators, Operators and Industries, in particular in ITU-T where the European priorities need to be shared and harmonized with those of the rest of the world.

*ETNO Energy Task Team initiatives*

Joint activities among main European Telcos (Belgacom, BT, C&W, CYTA, DT, Eircom, FT, KPN, Swisscom, Telecom Italia, TeleDenmark, Telia Networks, Telia Sonera, …) are foregoing within ETNO Energy Task Team on the energy issue, to stress the importance of energy consumption reduction and share experiences on this issue, also through push on standardization bodies for power management in the new standards [5].

## VI. Further aspects for a Sustainable Deployment of active equipment in the Access Network

Given the Network evolution towards the NGN paradigm, Operators will aim towards hardened equipments able to cope with much wider ambient temperature and humidity ranges. This in order to minimize the need of active air conditioning systems allowing therefore the techno-economical viability of the overall solution. In general, passive cooling should be the first option, when viable. ETSI EE and ITU-T SG6 are focusing on this topic.

Another issue related to the introduction of the new FTTCab-VDSL2 architecture is the need of improvement on the mechanical aspects to enable a reduction of the needed space. Costs and the urban impact are among the main factors that need to be considered and their minimization is the key for the successful development of the new services, considering the today's lack of available space in the existing cabs and the great difficulties in obtaining new Right Of Way authorizations from local Authorities for new outdoor installations.

Another new challenge related to the next generation access network (with lots of distributed active nodes placed outside the CO) is also represented by the study and identification of possible power back-up sources for service availability.

The two main possible alternatives are:

- traditional local powering with batteries (but these are generally a problem in outdoor installation, with wide range of external temperature variations ….)
- remote powering from CO (without batteries at the cabinet, but with line and conversion losses ….)

But also an extreme/disruptive scenario could be evaluated such as local powering without batteries, in association with the possible, future availability of a Public Mains power supply with higher reliability level (gold).

Whenever battery backup will be adopted for remote equipment in the access network, new, longer life and environmentally friendly technologies for batteries to be placed in outdoor cabinets will be needed.

TELCOs are also exploring pros/cons related to adoption of super or ultra capacitor solutions for the future access network. In this case the main obstacle is represented by the current reduction of the reliability when operating at the highest temperatures.

## VII. Alternative and Renewable Energy sources for Telecommunications

Telecom Italia is analyzing possible alternative energy sources to be adopted in the power feeding of its network, matching a national energy policy scenario leading to deeper attention to energy savings and usage of alternative energy sources.

The Group interest in the most promising technologies in the field of alternative energy sources comprises the following field trials:

- fuel cells (through new storage technologies, these plants use hydrogen as energetic back up for powering mobile telephony transmission equipment);
- traditional photovoltaic plants;
- innovative concentration photovoltaic plants.

## VIII. Conclusions

The forecoming telecommunications network (r)evolution, with the starting of Next Generation Access Network's deployments, represents for TELCOs a challenge on innovation, efficiency and competitiveness, taking into account also the Social Responsibility on Companies. To this end, energy efficiency represents for sure a strong enabler.

Commitment towards energy saving, with special attention to environment and sustainability issues (e.g. global warming, Kyoto protocol,…), has a positive impact in terms of Social

Responsibility and Corporate image too, but it can also pave the way to a greater competitiveness in the market arena. A strategy oriented towards Energy Efficiency can conciliate benefits for the Company with benefits for the whole Community.

To win the challenge of energy consumption control and reduction in the network's evolution, TLC Operators will have to be efficient and flexible to face the new market challenges, much more than in the past. Specifically, they will have to aim to:

- optimization and efficiency at equipment level ("intrinsic efficiency"), in particular with:
  - push towards system/chipset vendors (strong attention to the power consumption since the early design phase of new broadband equipment)
  - further actions towards standardization bodies (ETSI, ITU-T)
  - actions also at (inter)national Government level (e.g. UE CoCs, ETNO, …)
  - setting of specific Key Performances Indicators (KPI); for example Telecom Italia has recently introduced the Eco Efficiency Indicator in its financial reports
- choice of the most suitable architectural solutions (e.g. total replacement vs. overlay deployment)
- further optimization and efficiency in HVAC (Heating, Ventilation Air Conditioning) and Energy System domain in the new network paradigm
- Total Cost of Ownerships (TCO) criteria for new systems/equipments purchasing phase, including also the OPEX for energy consumption during the calls for bids
- study and identification of possible innovative and alternative (and renewable) energy sources which can be adopted in the telecommunication field, minimizing environmental impact and maximizing the service's quality
- new investments on technological R&D for NGN2's innovative environments ("invest today to save tomorrow")

Telecom Italia has a strong commitment towards all energy saving initiatives and believes that the only successful strategy must envisage a strong and continuative collaboration with Operators, chipset/system Vendors, Standardization and Regulatory bodies.

## REFERENCES


[1] http://www.globalcompactsummit.org/agenda.shtml
[2] http://www.telecomitalia.com/cgi-bin/tiportale/TIPortale/ep/home.do?LANG=EN&tabId=3
[3] http://www.telecomitalia.it/sostenibilita2006/English/A01.html
[4] http://re.jrc.cec.eu.int/energyefficiency/
[5] http://www.etno.org/