Chapter 3
Broadband ICT and Smart Grids: A Win-Win Approach

Stefano Nocentini, Roberto Gavazzi, and Lorenzo Maria Pupillo

Introduction

Energy is a fundamental input to economic activity. Energy services light up our homes, offices, and schools, allow production and distribution of goods, offer comfort and mobility, and contribute to health and well-being.[1] Energy is everywhere around us, but, as human beings, “we extract” energy in a very expensive and inefficient way, with heavy environmental impacts.

Information and Communication Technologies (ICTs) can contribute to decoupling environmental degradation from economic growth. Indeed, our society has just begun big changes thanks to ICTs (Internet and mobile communication). In the coming years, the “Internet of Things” could be realized if energy will be “scavenged” by the sensors directly from the environment (environmental energy). The environmental energy could also be increased by new techniques of wireless energy transfer. This futuristic scenario calls for changes, in the short run, in the way energy is produced (renewable sources), distributed (energy induction and energy scattered needs), and consumed (smart energy at home).

For these reasons today, many new players are entering the market of energy production, distribution, and management. The European Community is preparing itself

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[1] See OECD (2012) *Energy, OECD green growth studies*. OECD Publishing.

S. Nocentini (✉)
Telecom Italia, Via Pietro dei Francisci 152, Roma
e-mail: stefano.nocentini@telecomitalia.it

L.M. Pupillo
Corso d’Italia 41, Roma
e-mail: lorenzo.pupillo@telecomitalia.it

R. Gavazzi
Via Guglielmo Reiss Romoli 274, Roma
e-mail: roberto.gavazzi@telecomitalia.it

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for a dramatic transformation of the energy sector and the European Commission[2] is working hard to enable changes, leveraging European assets and values.

Facing the challenge of the EU 20-20-20 sustainability targets, many countries are trying to increase the use of renewable power sources[3] and to improve consumption efficiency. Moreover, new and more efficient major appliances [note apparently "white goods" is only used in British English so you can keep it if you like, but American readers would have to guess at its meaning] are coming on the market.

In the last two decades, the telecommunications sector went through significant changes, including:

- The switch from analog to digital: the TLC network changed and became "Digital."
- The transition of households from being merely consumers of information to also becoming prosumers (producers and consumers at the same time) in the Internet world.
- Structural changes in the market whereby many new entrants are now competing with the incumbents.

In the next decade, similar changes are going to happen in the electricity sector as grid equipment becomes digital and digitally controlled ("Smart"). The consumers will be, at the same time, consumers and producers of energy. The market is opening up and the incumbent utility will be required to provide competitors access to its electric network, a greater flexibility of the electric grid will be called for, and the grid will become "smarter."

Overall, the convergence of the telecommunication and energy sectors could represent a quantum leap in the evolution of human civilization: energy and communication are basic needs for the single human being and are basic needs for the society as whole, like in biology ontogeny recapitulates phylogeny (the development of a single complex organism goes through very similar phases especially in the pre-natal period to the phases of evolution of his own species).[4] The way to produce and consume information and energy can dramatically change human civilization and society.

As suggested by Jeremy Rifkin: *The great economic revolutions in history occur when new communication technologies converge with new energy systems. New energy revolutions make possible more expansive and integrated trade. Accompanying communication revolutions manage the new complex commercial activities made possible by the new energy flows. In the 19th century, cheap print technology and the introduction of public schools gave rise to a print-literate work force with the communication skills to manage the increased flow of commercial activity made possible by coal and steam power technology, ushering in the First Industrial Revolution. In the 20th century, centralized electricity communication -- the*

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[2] See European Commission set plan definition: http://ec.europa.eu/energy/technology/set_plan/set_plan_en.html.

[3] See Eurostat—renewable energy statistics: http://epp.eurostat.ec.europa.eu/cache/ity_offpub/ks_sf_10_056/en/ks_sf_10_056_en.pdf.

[4] See Wikipedia ontogeny definition: http://en.wikipedia.org/wiki/ontogeny.

telephone, and later radio and television -- became the communication medium to manage a more complex and dispersed oil, auto, and suburban era, and the mass consumer culture of the Second Industrial Revolution.[5]

From the Grid to the "Smart" Grid

Due to the increase of environmental disasters and Ozone depletion, an urgent reduction of pollution is needed. The "Green Push" effect is already producing some improvements, but it is not enough. In order to reduce city pollution, the use of renewable sources will need to be increased and the adoption of electric vehicles should be promoted.

The way in which energy is produced, distributed, and consumed is becoming more and more important. Indeed, blackouts can be very dangerous and expensive for a country's economy and therefore should be avoided

At the same time, consumers must become more and more aware of their energy consumption, because there is evidence from many trials and studies that awareness reduces consumption from 10 to 20%. Instead, today consumers are informed about their consumption only once a month or once every 2 months. Furthermore, by using consumer energy consumption profiles in real time, utilities will be able to increase energy efficiency and reduce energy peak.

Today, the main problem is that the current grid is not designed to support and satisfy these needs. Therefore, the grid must undergo the transformative processes that will make it smart. The Smart Grid is not a system! It is the concept of modernizing the electrical grid with ICT technologies.[6] In contrast to the traditional grid, the Smart Grid should manage power production, transmission, distribution, and consumption in a more efficient and flexible way.

The Smart Grid is important in the energy production phase because it has to manage the discontinuous nature of energy supplied by renewable sources The Smart Grid is also critical in energy distribution because the energy available should arrive at the consumers premises in an efficient way (reducing losses) and when it is really needed (demand—response). Moreover, the energy overflow should be managed through smart power storage. A first example of Smart Grid implementation is given by the usage of telemeters to transmit in real time consumption data using different Radio Frequency (RF) technologies like power lines, GPRS/UMTS mobile data, and FTTH fiber optics networks. The power lines can be used for data connection between the telemeter and the first substation, but also the broadband connection already available at customers home is recommended. In the substation, data

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[5] Jeremy Rifkin. "How the 99 % Are Using Lateral Power to Create a Global Revolution" 8/11/2011—From Huffington Post.

[6] Gavazzi R, Pupillo L (2011) "Telecom Italia's View", European Commission, 2nd workshop utilities and telecom operators on Smart Grids (5/10/2011).

from various telemeters are collected and sent to grid control centers using GPRS or xDSL techniques. However, while Internet protocols (TCP/IP especially) are commonly used, the usage of the public internet should be avoided due to performance, safety, and security problems.

Another aspect of the Smart Grid is provided by an ICT platform able to control energy routing. In an “energy district,” it is important to balance supply and demand of energy. The Smart Grid enables supporting storage or selling of surplus energy, thereby avoiding energy losses. Furthermore, it supports managing demand peaks (using for example ad hoc cost plans able to shift consumers usage of energy to off peak time periods).

The main Smart Grid functionalities are:

- Renewables management.
- Demand Response and Load Control.
- Energy Storage and distributed energy management.
- EV (Electric Vehicle) management and charging and discharging control.
- Smart metering.
- Grid management (maintenance, self-heal, provisioning).
- Grid value added services provision:
  - Flexible Pricing and pre-payment management.
  - Flexible Billing.
  - Flexible provider choice.

The most relevant advantages of the Smart Grid are:

- Energy consumption reduction and pollution reduction.
- Energy production efficiency increase.
- Consumer active participation in the “energy cycle.”
- Grid management cost reduction.
- Dynamic market energy management (opening the market and leveraging to new business models and value chains).
- Renewable sources and electric vehicle deployments.
- Virtual and actual Energy Storage deployments.
- Reliability increase (Power failure time/year/household and blackouts reduction).
- Resiliency increase against terrorists attack and natural disaster.

Smart Grid: Ways of Promoting Synergies and Faster Rollout

While there is a general consensus that ICT plays an important role for the deployment of Smart Grids, there is no general agreement on how ICT platforms should be integrated and used in the Smart Grids. Indeed, some electric utilities would like to implement a dedicated telecommunication layer for the Smart Grid network. Instead, The European Commission is pushing for possible synergies between Telco operators and utilities to speed up the roll out of smart grids by leveraging existing TLC assets and infrastructures.

ICT could contribute to Smart Grid deployment in the following areas:

- Availability of smart digital devices ICT based (with computing and data communication capabilities embedded).
- Communication networks (access and core).
- Computing capabilities (for algorithms managing the flexibility of the grid).
- Application platforms capabilities.

To realize the Smart Grid, the electric grid equipment should become "smart," meaning that they should be digitally controlled with processing, memory, and communication capability on board (using micro controllers and microprocessors). This smart equipment should exchange data with and be controlled by the grid's remote center systems/platforms. For data exchanging, communication networks are needed. The networks should be IP-based, but the public Internet cannot be used for security and performances reasons. Computing and servers capabilities are needed to run support services in the middleware as well as applications.

Therefore, ICT capabilities are necessary for peripheral devices and grid control center, while a data network communication infrastructure should support the two ways data transfers. Moreover, the Smart Grid implementation is going to be based on a M2M middleware platform[7] managing the communication and functionalities of sensors networks (in particular WSN—Wireless Sensor Networks) and servers in control centers. For M2M (Machine to Machine), we mean the set of service platforms and technology solutions enabling the Remote Data Acquisition & Control of remote devices in which the human interaction is close to zero.

Standards State of the Art

The standardization activities are very important for the Smart Grid realization for the same reasons and in the same ways they have been important in the telecommunication sector. Only through standards will the costs of new networks be able to exploit economies of scale. Furthermore, standards can guarantee interoperability between different network segments and between different networks in different countries. Finally, standardization allows consumer grid equipment to be bought directly by consumers without any additional interface or adaptors

The European Commission has set up a JWG (Joint Working Group) on standards setting for Smart Grids involving the main standardization bodies (ESOs): ETSI (European Telecommunications Standards Institute), CENELC (European

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[7] Rocca G, Gavazzi R, Larini G, Annoni M, Lupano M, Scarrone E, Veltri P (2011) M2M platform and vertical applications: the experience of telecom Italia lab—ETSIM2M workshop—Sophia Antipolis (FR)—26/10/2011.

Committee for Electro technical standardization), CEN (European Committee for Standardization). The main objectives of this JWG are: to define the functionalities of the Smart Grid, to define regulatory requirements, and to define the actors and the roles in the development and operation of Smart Grids. The outputs of the JWG will be provided to the standardization bodies (e.g., ETSI). The JWG will interact with extra European organizations like: NIST (National Institute for Standard and Technology), JISC (Japanese Industrial Standard Committee), and SGCC (State Grid Corporation of China). ESOs operate numerous further liaisons (e.g., with ITU—International Telecommunication Union, 3GPP—Third Generation Partnership Project, etc.). On the other hands, IEEE is working on Smart Grid standardization with its P2030 standard (and related P2030.1 "Electric Vehicle," P2030.2 "Storage Energy Systems"). The IEEE P2030 is a Standard guide for Smart Grid Interoperability. It addresses the basic Smart Grid definitions, frameworks, challenges, and three different architectural perspectives: Power & Energy, Communications, and IT. The model is quite similar to other models (including the ETSI model described below) and it is based on three foundational layers: Information Technology Layer, Communication Layer, and Power and Energy System Layer.[8]

Finally, in the USA, the NIST has set up a group called SGIP (Smart Grid Interoperable Panel) to support NIST's mission derived from the Energy Independence and Security Act of 2007. In particular, the mission of the SGIP is to provide a framework for coordination of all Smart Grid stakeholders to accelerate standards harmonization and development. The SGIP group does not write standards, but develops and reviews use cases, identifies requirements, and proposes action plans for standards development and harmonization.

The main challenges of Smart Grid standardization are: horizontal complexity (Silos vs. holistic view), number of stakeholders involved (ICT and Energy companies, Consumers, etc.), different innovation speeds and life cycles of the components (electrical components vs. ICT components), moving targets (premature R&D, pilots, and demonstration projects), political influence (regulated markets), and race for global standards with a lot of different bodies in different countries (premature standards may be pushed internationally due to economic interests of multinational companies). Overall, Smart Grids do not represent a business-as-usual scenario, due to the large number of players and disciplines, scattered activities (from local to regional to international), and policy and regulation at the intersection between electricity and telecommunication.

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[8] It is important to quote also ITU-T Smart Grid Focus Group that has the following objective: to collect and document information and concepts that would be helpful for developing Recommendations to support Smart Grid from a telecommunication/ICT perspective. The ITU-T approach is quite similar to the IEEE approach but the three layers are called: energy layer, communication and control layer and service and application layer. ITU-T is managing the relationship with ETSI in particular also with ETSI M2M (Machine To Machine) standardization group. ETSI architectural approach is very similar to the ITU-T approach.

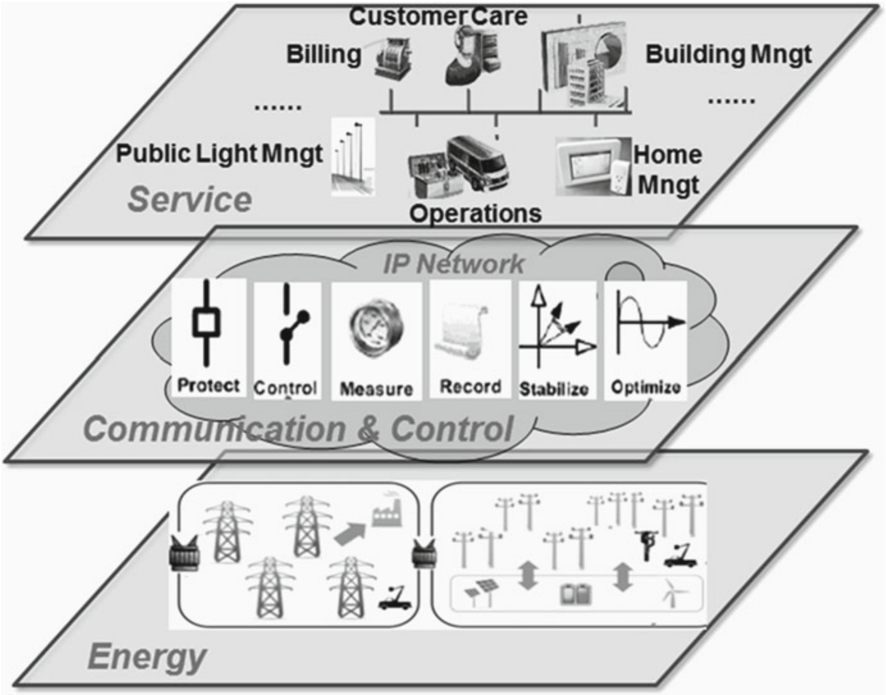

Fig. 3.1 ETSI Smart Grid layered architecture

All the European work on standardization is based on European Commission Mandate M/490. The objective defined in this mandate is to develop or update a set of consistent standards within a common European framework integrating a variety of digital computing and communication technologies, electrical architectures, and associated processes and services. This will achieve interoperability and will enable or, at least facilitate, the implementation in Europe of the different high level Smart Grid services and functionalities as defined by the Smart Grid Task Force. These high level functionalities and services will be flexible enough to accommodate future developments. The Mandate M/490 is strictly related with the following Mandates: Smart Metering Mandate M/441, Electrical Vehicle Mandate—M/468.

As part of these running activities on standardization, ETSI has provided a general reference architecture (again very similar to IEEE and ITU-T architectures) that explains the different layers of interaction between ICT and Smart Grid. This standard architecture is shown in the Fig. 3.1.

As it is shown by the previous figure, the ETSI architecture is based on an IP network for Smart Grid Communication & Control layer that can be based on current Telco networks and an application layer very similar to the Telco application layer.

Moreover, in the ETSI M2M group, Smart Grid use cases have been studied and a series of different ICT applications have been defined for each segment of the electric grid. The WAMS (Wide Area Measurement System) is a HV (High Voltage) Transport & Distribution Network stability threats management capability. The stability problems can be caused by volatile regional energy generation, becoming increasingly important when introducing power plants relying on sun or wind energy in large scale. As it can be seen from recent nationwide failure events, blackouts causes are propagating within minutes and sometimes only seconds through entire national and even international transport & distribution networks. Proper state information about the initial network health status can be obtained from Phase Measurement Units equipment ("PMUs, also known as Synchrophasors") over a whole country or even beyond. In this use case PMUs are connected via a communication network that can be a Mobile Broadband network, thus not requiring any additional Distribution and Transmission internal network extensions. Of course, when using a public 3G/4G communication infrastructure, sufficient power back-up resources should be available to the network, but this is of course true for dedicated networks as well. The nationwide ICT platform and Network will enable the control of the threats avoiding catastrophic blackouts. Another important ICT network and platform is the DER (Distributed Energy Resources) control. When dealing with many DER in an Energy Network, most of the resources will be connected to the Medium Voltage distribution network due to their distributed nature.

With the help of regional energy management, distributed generation may be controlled according to demand. Therefore, better distribution networks protection becomes also possible on a regional rather than on a local basis. DERs, communicating with their regional MV (Medium Voltage) control center via public wireless networks, seem to be the most viable solution; from the communications availability and data throughput standpoints. DR (Demand Response) control capability is also an important new capability for the Smart Grid. The basic goal of DR is to stabilize the network, by equalizing peak energy demand over short times (quarter hours range), and to protect the distribution network against black-out situations or support the recovery process following a black-out.

The real time control can be guaranteed by an IP mobile network (the bandwidth required is of the order of magnitude of Kb/s and the latency required is of the order of magnitude of seconds). Distribution System Supervision Smart Grid capability primary objective is to notify faults in distribution network faster than end users would do and to analyze the fault situation in more detail from remote. It shall have many distributed supervision points/spots in the Smart Grid and it shall be integrated in the same network of DER and DR. Going to the local level of the Smart Grid, it is important to quote DER/DR Micro grid control capability. The objective of local DER/DR is to establish a control at micro grid level. So the renewable sources and the demand response are managed at local level and both peak demand and peak energy availability shall be managed by an ICT platform and network. Such a platform shall be integrated with the Regional and National level ICT platform. In this case the capillary network for local control can use also short range protocols like ZigBee, Z-Wave, or Power Line. Finally, Electric Vehicle (EV) charging and power feed is a smart and controlled charging system ICT platform and network to control the EV charging infrastructure.

The Smart Metering Case

The smart metering is a basic functionality for the Smart Grid.[9] In the NETL terminology (National Energy Technology Laboratory—US Department of Energy—DOE), smart metering is also called AMI (Advanced Metering Infrastructure). Here the term "Infrastructure" means that there are sensor networks interconnected with communication networks at different level. Starting locally from HAN (Home Area Network) going to NAN (Neighborhood Area Network) or FAN (Field Area Network), finally going to WAN (Wide Area Network). Each network can have different protocols on the basis of range and coverage needs:

- HAN—WI FI, ZigBee, 6LoWPAN, Z-Wave.
- NAN—WI MAX, Mesh RF networks, PLC.
- WAN—2G, 3G, 4G, Fiber and xDSL, satellite.

The meters could also have directly a 2G/3G/4G or a DSL connection, so they connect directly to the Command and Control Center using Telco networks, without going to the local networks (HAN, NAN, FAN). In case of usage of fixed DSL connections, a reuse of the internet connection at home is strongly suggested to reduce Smart Grid costs. For the meters applications at home, there are not usually hard real time constraints (i.e., latency) like there are in case of teleprotection applications. Therefore, a standard Internet connection can be used also considering that the measures of a meter shall be time tagged. The time of the measure is taken locally and then sent, together with the measure, to the Command and Control Center.

The main metering capabilities, already available in the grid today, are: meter reading, net metering, energy time of use, basic outage detection, and large load demand limiting. In the medium term (Smart Grid 1.0), the following capabilities will become available: pre-paid metering, in-home displays, energy usage profiles definition, intelligent disconnect, fine-grain load control, advanced outage management, bi-directional metering (renewables), and demand response. In the long term, (Smart Grid 2.0) the following applications will be available: micro-grids/distributed generation, intelligent street lighting, vehicle to grid/grid to vehicle, storage/distribution of renewables (wind, fuel cells, solar), fault prediction/outage prevention, energy asset management, and automatic demand response. Smart Metering is also important for Demand Response (DR) capability. A good DR algorithm can enable great energy savings and avoid the unbalancing of the electricity network. In particular, a good DR management can reduce peak impact on the network. Indeed, today the electrical network dimensioning is done considering peak consumption (in order to avoid blackouts, peaks are managed by increasing energy production). The DR algorithm manages the energy demand by shifting consumption from peak to off peak hours. The DR control requires smart devices and smart meters, a communication network and an ICT application platform to command and control

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[9] ESMIG (European Smart Metering Industry Group) (2011) "Position Paper on Smart Grids" an ERGEG Public Consultation paper, E09-EQS-30-04.

the DR policies automatically. A good metering infrastructure enables daily or even hourly consumption data acquisition, providing historical data to be used for consumption estimations. A good consumption prediction can decrease the production/consumption unbalancing, thereby increasing the efficiency and decreasing the energy wastes.

The energy metering at home is also a very powerful means to increase consumer awareness of consumption in real time. Many studies have demonstrated that consumer energy awareness can generate savings from 10 to 20%. This result can be achieved displaying consumption at home through a user-friendly meter with a display or using home PC or tablet or smartphone as a display and as a monitor to control the home appliances from remote. Indeed, many smart home applications with these features are already available on the market.

Finally, the challenge of the long life cycle of the meters should be considered. Utilities deploy meters for long periods of time, while the ICT technology and devices change constantly. Therefore, smart meters should provide flexibility to re-shape their functions, services, and communications capabilities according to changing needs. Smart Meter upgrades must be made effectively without visiting the meter and upgrades should verify strict security provisions for their originator. What is needed is a flexible and smart meter management platform that can accept remote device upgrades for its components and respond with increased communication bandwidth, storage capabilities, functions, and services.

The ICT and TLC Reference Architecture for the Smart Grid

The cases described previously have a common issue: they all require an ICT infrastructure to be implemented. With ICT infrastructure, we mean digital computation and communication capabilities. The reference architecture for such an infrastructure is described in Fig. 3.2.

In the reference architecture there are the following three layers:

- Devices Layer.
- Networks Layer.
- Applications Layer.

The Devices Layer is composed by many types of smart devices (meters, actuators, sensors, electrical grid devices) that should have both computation and data transmission capability. The data transmission capability, as already described in the previous sections, can be radio frequency short range; in this case, there should be a gateway to interface the long range data networks or, in case of more complex/capable devices, directly a Telco networks data connection (xDSL, 2G/3G/4G, fiber, etc.). The short range and capillary network connecting different devices in a small distance can rely upon smart spots already available like: public telephone cabins, Telco cabinets, street lighting, and electrical substations. The gateway between the short range capillary network and the Telco networks shall be positioned in these

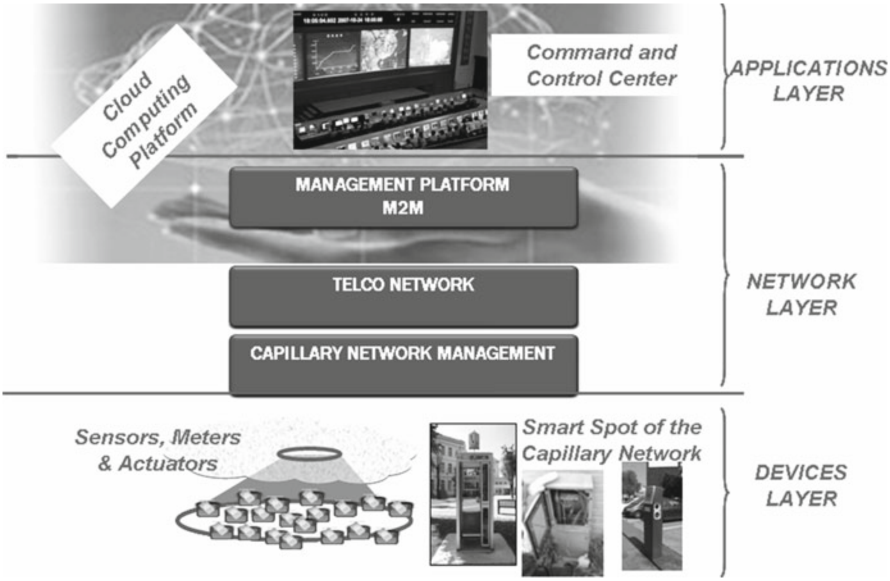
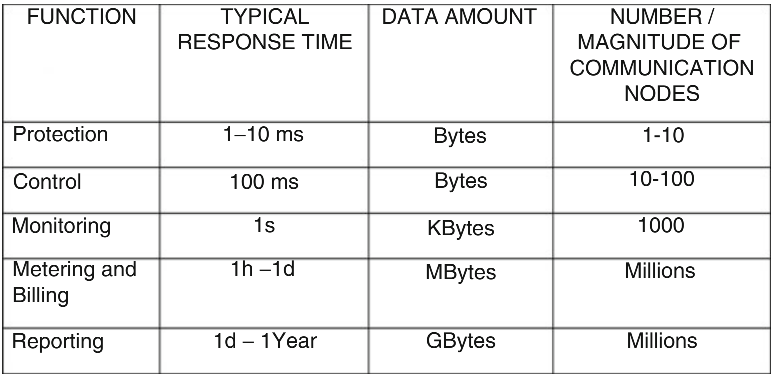


Fig. 3.2 The ICT Smart Grid reference architecture

smart spots that will behave like data collection points. When data are collected, they should be sent to the application platforms available "in the cloud" using Telco networks. All the devices should be managed by a M2M (Machine To Machine) platform with the following main capabilities: open and standard interface with devices, open and standard interface with applications, legacy, non-standard, adapters, devices and applications self-discovery and identity management (access controls), connectivity management (session, mobility), content management (QoS), security, privacy and trust, service management (auto provisioning, auto configuration, self-healing, SW and FW upgrade, …) for applications and devices, asset management (SIMs card for example).

The M2M and the application platforms (command and control) for cost optimization and energy efficiency should be available in a cloud platform that allows remote access by optimizing ICT costs for the electrical utilities. In Telecom Italia's case, the Cloud platform is already available in the network and it leverages all the network capabilities including QoS (Quality of Services). Moreover, the M2M platform is in part already available in the Telecom Italia network and it will be expanded in the next years not only for Smart Grid devices and applications, but also for the vast amount of M2M devices and applications foreseen in the future. Therefore, Telecom Italia is ready to offer ICT services (not only connectivity) to the Smart Grid. The capillary network needed for the Smart Grid should also leverage the Telco network spots of Telecom Italia available throughout its service territory (cabinet, telephone cabin, etc.).



FUNCTION	TYPICAL RESPONSE TIME	DATA AMOUNT	NUMBER / MAGNITUDE OF COMMUNICATION NODES
Protection	1–10 ms	Bytes	1-10
Control	100 ms	Bytes	10-100
Monitoring	1s	KBytes	1000
Metering and Billing	1h –1d	MBytes	Millions
Reporting	1d – 1Year	GBytes	Millions

Fig. 3.3 ETSI M2M preliminary estimation of Smart Grid requirement

Regarding data connectivity, the debate is open and operators are assessing if public Telco networks can be reusable for Smart Grid communications. In particular, the discussion is centered on the Smart Grid requirements in terms of bandwidth and latency time for time critical application.

Besides the reliability of the commercial public networks, some electrical Distribution System Operators (DSOs) also highlighted the problem of latency time requirement for Teleprotection applications. In Fig. 3.3, there is a draft description of latency requirement defined by ETSI M2M under discussion and evaluation.[10]

On the basis of these requirements, only the requirement for "Teleprotection" is very challenging for current commercial networks. The long-term evolution (LTE) techniques in the NGN mobile networks are able to satisfy such challenging latency performance requirement. In particular, the round trip delay for the data plane can be less than 10 ms, while for the control plane the latency to pass from idle to active state can be less than 50 ms, considering only the access segment of the network (Release 10 of the standard.[11]). So if we consider LTE we cannot say that the latency requirement for "Teleprotection" cannot be satisfied, but it would be essentially a matter of cost and real usage conditions. Anyway, the number of communication nodes for grid "Protection" is very low compared with the number of communication nodes needed by other Smart Grid capabilities. For this reason, it is possible to think to ad hoc solutions for the "Protection needs" (e.g., local management or point to point fiber without backbone). Indeed, it is a big technical challenge to satisfy the

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[10] M2M Applicability of M2M architecture to Smart Grid Networks—Draft ETSI TR 102 935—09/2010—ETSI M2M Standard.

[11] 3GPP TR (Technical Report) 25.913 "Requirements for Evolved UTRA (E-UTRA) and Evolved UTRAN (E-UTRAN) (Release 9)."

3GPP TR (Technical Report) 36.913 "Requirements for further advancements for Evolved Universal Terrestrial Radio Access (Release 10)."

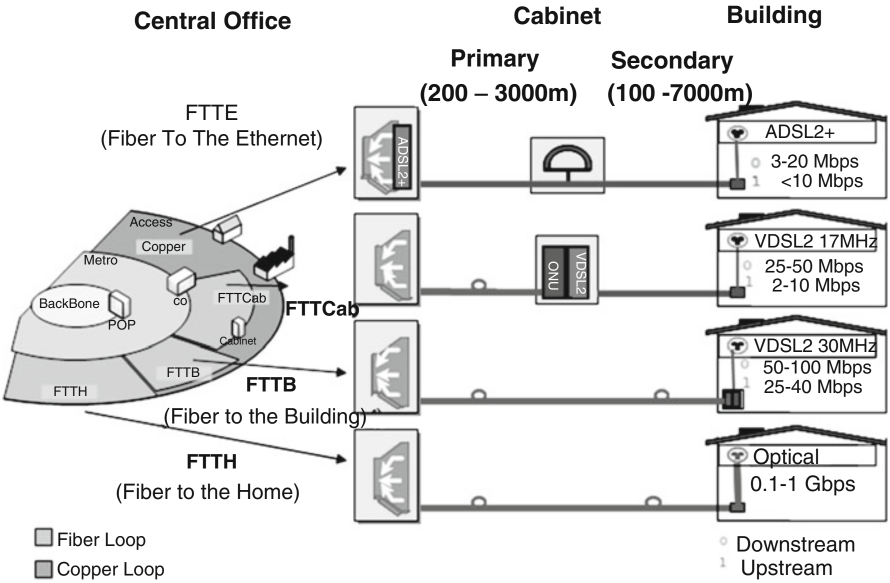

Fig. 3.4 Next generation access network (fiber optics)

latency required taking into account all the different times involved (communication, computation, and equipment response). Instead, for other capabilities, it is surely possible to use public NGN Telco networks hardened to support mission-critical Smart Grid applications with affordable latency requirement as suggested also by the USA Federal Communication Commission.

On the bandwidth capacity issue, the FCC's National Broadband Plan[12] estimate is 200–500 Kbps. Using Telecom Italia's experience in research projects, we can confirm that 100 Kbit/s of bandwidth are enough to satisfy the very basic functions of the Smart Grid

The NGN Telco networks are really improving their performances especially in terms of bandwidth. Telecom Italia is deploying the following new technologies:

- Next Generation Access Network (NGAN) based on fiber optic cable technologies enabling very high bandwidth also to Small and Medium Enterprises (SME).
- LTE mobile ultra broadband. LTE is the evolution of GSM, UMTS, and HSPA and improves the quality of mobile broadband service enabling new applications, bandwidth intensive also "on the move."

The architecture of NGAN offers many options as shown in Fig. 3.4 and Telecom Italia is going to deploy them in Italy.

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[12] FCC (Federal Community Commission) National Broadband Plan—Connecting America—Chapter 12 "Energy and the Environment": http://www.broadband.gov/plan/12-energy-andthe-environment."

LTE is going to provide bandwidth towards 86 Mbps uplink and 326 Mbps downlink but even more. The LTE has an optimized network architecture specific for data packet transmission, flexibility in bandwidth spectrum usage (1.4, 3, 5, 10, 15, 20 MHz), advanced antenna systems (MIMO and Beam forming), and new access radio techniques (i.e., OFDM) and management. These NGN architectures will have no problems of bandwidth and also the latency can be set up using QoS network capabilities. Another important issue to be considered is the geographical coverage of the territory of both fixed and mobile networks. LTE and NGAN will initially cover city centers and business districts. This coverage will not match exactly with what is required by the Smart Grid. Therefore, additional coverage dedicated to Smart Grid requirements is likely needed.

Conclusions

Smart grids can contribute to saving energy and reducing CO_2 emissions. Smart Grids need a new data communication network that requires time and huge investments to be built. The win-win solution is a synergy between telecommunication networks and electricity grids.

Telco public networks have to be hardened for satisfying resiliency, reliability, and geographical coverage required by smart grids. Due to the growing quantity of endpoints requiring connectivity in the Smart Grid, it is possible to foresee a significant increase of amount of data to be transmitted. Narrowband will not be sufficient and broadband and ultra-broadband Telco networks will provide many benefits to the Smart Grid.

Finally, telecommunications networks are already available, are managed (i.e., they offer planning, provisioning, and assurance), are already secure both at physical and application layers, and are able to integrate data centers to manage vast amount of data that smart grids will generate.

The road to follow is a strong cooperation between the two industries.

Acknowledgment We thank Sandford Malman for helpful comments.

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