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# FUTURE IS T-SMART

## Introduction

Municipality of Terni is in the north of Umbria Region, situated right in the middle of the boot-shaped peninsula of Italy. Abandoned natural water reserves gave this territory important energy resources, which back in 1800, facilitated an intensive industrialization of the hydroelectricity generation, steel and chemistry industries. To this day, the territory of Terni is known for valuable electric power production and distribution establishments that benefit local enterprises as well as the society.

ASM Terni Ltd is a multi-utility company operating in the specified territory and is fully supervised by the local public authorities. ASM TERNI Ltd is a provider of main public services, one of which is electricity production and distribution and is an important factor affecting local economical development as well as growth of civilised society.

Aforementioned multi-utility company plays a crucial role in socio-economical development of the area, and has been recognized since its establishment back in 1960. To this day, the electricity distribution sector is one of the most important company's working field, and is successfully keeping up with the large scale progression of the sector, caused by the expansion of energy production plants and predictions for further changes introduced by the electric vehicle use spread. The local electric grid has shifted from carrying power one-way, towards the high-voltage national grid, to two-way flows of electricity, and the supplier is required to redesign it's infrastructures in order to keep up with the current technological

evolution; such requirement can become an opportunity assuming that one is capable to provide new services to the customers and therefore capture new business ideas. The new "smart" grid management technique provides a large amount of information to be managed and processed through the new systems and using the qualities available due to the Information and Communications Technology (ICT).

ASM TERNI, following the guidelines and legislations of The Regulatory Authority for Electricity and Gas (AEEG), has entered a progressive circuit, beginning with the installation of a modern system Smart Metering, following the launch of the Smart Grid experimental project. At the moment the company is going through its roadmap towards a technological evolution by participating in the project FINESCE (Future INternEt Smart Utility ServiCEs) under the Seventh Framework Programme where the analysis and experimentations in the field of Demand Response will be carried out. The following step will be to develop experimental technologies and use newly gained qualities to fulfil the idea of the Smart City.

The engine that drives this evolutionary process towards an intelligent city is nothing else but the so called "20-20-20" targets of the European Union, setting three key objectives to be fulfilled by 2020: a 20% reduction in EU greenhouse gas emissions from 1990 levels, a 20% improvement in the EU's energy efficiency and raising the share of EU energy consumption produced from renewable resources to 20%. In te case of Italy, this means an achievement of 17% electricity produced from the renewable resources by 2020.

A shift towards renewable energy sources alters the relationship between electricity demand and supply: while until now the electricity has been produced satisfying the demand, from now on electricity will have to be consumed upon the increment of electricity produced, considering that production of electricity from the renewable resources bring up factors that cannot be controlled by human. The issue could be overcome by introducing storage for an excess of electricity, however such approach has already been outdone by other sectors such as industrial production and logistics, which in fact, by applying "Just in Time" strategy in the 70ies, have declared "the end of storage". However, a new approach of storage is introduced – the electrical mobility. It is an intelligent storage for electricity without an actual storage space; in addition, batteries charged at the times of highest supply would be a ready-to-use product without any energy transformation needed, therefore would be highly efficient. Production and consumption of electricity locally eliminates the transportation of electricity and related energy losses, just like the consumption of local agricultural goods implies the reduction of costs of

transportation and level of CO2 emissions. Such logic, tied to the industrial production, leads to the reduction of energy costs and could be a way to control or even reduce the production costs, in particular taking into account the territory of Terni, which is largely industrialized.

## 1. Conditions of competition in Terni's industries

The beginning of modern industrialization in the city of Terni took place between 1700 and 1800 and was controlled by public institutions, which have seen a great potential to set up important steel and chemistry industry settlements, keeping in mind the location of Terni, which is in central Italy not too far from capital Rome, and at the same time has a great accessibility to hydroelectricity resources.

Above-mentioned industrial model was in place until the mid 1900, when various national ad international political-economical conditions gave way to a long process of privatization, and the industries of Terni were of a great interest. The investments, drawn to the industries of Terni, were attracted by the competitive advantages of the industries, process of technological evolution and highly qualified labor. Such image is favored by more than 20 multinational companies until this day operating in the territory.

Despite the significant competitive advantage, the foreign investors raise an issue of a high cost of electricity, which in the territory of Terni – as well as in the rest of Italy – is estimated to be 30% higher than the average cost of main competitive countries in Europe. Therefore, it is urgent that electricity production and distribution companies find a quick solution to increase the efficiency, in order to reduce costs ad increase the flexibility of network management. Actions taken by ASM TERNI are implementing the modernization and innovation of the industries, facilitated by the competitive advantage of the territory and it's industries.

## 2. Smart metering

The electrical grid restructuring initiated by ASM Terni was given a go-ahead by the Regulatory Authority for Electricity and Gas (AEEG), which, for it's part, has set an objective for Italian suppliers to replace 95% of mechanical meters with electrical meters in the time spade of 3 years (2008-2011). The logic

behind such requirement is to computerize the electrical grids and is compatible with the growing use of information technology. The presence of the technological and economical efforts has already brought significant comebacks, for both, the suppliers and the consumers, through the services that would not have been available had the mechanical meters been used; for example: invoicing based on monthly readings, time based electricity prices, activation/deactivation during the times of peak demand, reduction of power before the cut-off due to the absence of payments. Previously manual procedures such as readings and contractual variations (power increment/reduction) became automatic with smart metering. Besides, collection of such data facilitates a profound understanding of the electrical grid behaviour.

ASM TERNI has successfully installed the smart meters and has activated a system that involves the use of management centre set up in the third part location; thus the system commissioning times were greatly reduced, overcoming the criticism with respect to server management, communication and data base management. In a case of power interruption, the supplier, via the operation of smart meters, can easily identify and register the consumers directly affected by the service failure, which brings a clear and evident advantage for the consumers benefiting from the refunds, as the service continuity is an important criteria defined by AEEG. Nonetheless, it is required to maintain the progressive growth of the system's IT management, as a result, indirectly participating in the growth of IT culture in the society. Through the automatic measuring management, the supplier has a possibility to enrich the distribution service with information, such as an hourly consumption, which is of a great help to rationalize the power consumption. Besides, the customers that are the producers of electricity as well as consumers, have a great tool to monitor the power produced and issued to the grid.

## 3. Project smart grid

Respecting previously mentioned requirements of AEEG, ASM Terni Ltd has received a second place award at the national level for the compliance with the values and criteria of AEEG. Consequently, the efforts made and experience received has stimulated a further goal focusing on Smart Grid Pilot Project. Accordingly, specific cooperation and research agreements have been signed between the scientific partner, Department of Astronautical Engineering, Electricity and Energy of the Sapienza University of Rome, and ASM TERNI Ltd.

The main purpose of the Pilot Project is to develop a grid module that would allow a greater advancement in the distributed generation and more effective grid resources usage, keeping the levels of security and reliability of the system high, as well as the level of service quality, while managing reactive power flow and carrying out a prosperous coordination between the producer and the distributor.

The realisation of a system with such features requires the innovative technology on the top of the conventional control systems.

Presently, the project is in the last year of implementation: the investments are being used and the data for experimental validation is being collected. The investments, made in two years with a pay-back in four years, equal to about € 1.000.000, are estimated to bring a profit in terms of efficiency of the grid (reduction of losses) and recovery of productivity by operative management.

It is emphasized that the full achievement of the aim set by pilot project (achievement of an efficient distribution grid) together with the availability of the full broadband connectivity, represent the necessary conditions for the development of application software, utilised by enterprises and customers, in order to integrate and process the information that defines the activity of participants in the open data area.

## 4. Demand response

Developed and implemented technology of Smart Grid is a technological base of the future Smart City. Smart metering, remote monitoring and communication infrastructure, whether wireless or optical, gives a technological platform for the collection of information, its processing and publication in order to introduce new services. For this reason, the public knowledge of the intelligent network potentials must be increased, spreading the information technology culture among the citizens and providing an access to the consumption data, with charts of hourly and quarter-hourly consumption.

In order to achieve such objective, ASM TERNI is proceeding with the experimentations of meter data management, in the working field of on-going project FINESCE. In particular, the consumption/supply charts of a certain number of users and the data processing system, able to work out the real time pricing, are being made available. These are required to achieve consumer-oriented energy consumption with the purpose of optimized efficiency of distribution grid along with profiting to the technology of the renewable energy sources. Incentives of hour-

ly based pricing and environmental benefits are the advantages, resulting from a more rational power consumption, and must be analysed and made available to lead an effective consumer participation in the network management. For these advantages, the supplier must take an active part in analysis of a current situation and possibly propose new tariff regulation frameworks. For example, the frameworks might be built representing the electric energy usage with significant variations of power available in different hours of a day or weekend. Such proposals should later be verified by consumer charts. By 2015, ASM Terni will conclude the experimentation in the field of Demand Response and present the results applicable for the large scale models.

The future vision for which ASM TERNI is working for, by providing an access to a proper electrical grid for a development of the pilot project, together with European partners, is the one to use an intelligent energetic system based on the future internet technology (Future Internet-WARE) and has a purpose to achieve the energetic efficiency and modulation of consumption (power request) to facilitate the power production from renewable resources. The main purpose of ASM TERNI, and other small-medium distribution networks managing companies, is, in the next few years, to reduce the dependence on foreign energy which would lead to reduced power purchasing costs, reduced loss due to the energy transmission, reduced environmental impact, caused by transmission network, and promoted use of power generated from renewable energy sources. These effects must be verified through the experimentations using a sample of consumers in order to evaluate the advantages to be able to proceed the extension to the whole internal local market.

## 5. Towards the electric vehicle

It is foreseen that in the near future the use of electric vehicles will grow rapidly. The data, presented by CEI-Cives (*Comitato Elettrotecnico Italiano – Commissione Italiana Veicoli Elettrici Stradali a Batteria, Ibridi e a Celle a Combustibile*) study, shows that the electric vehicle market has matured and is being promoted in many countries. The study demonstrates the findings as follows: (a) Great Britain has raised 260 million Euros aiming to create 400.000 work places; in particular, in London 25.000 charging points are to be set up by 2015; (b) France aims for 2 million electric and hybrid vehicles and 25.000 public charging points by 2020; an incentive plan that involves subsidies up to €6.000 for a purchase of an electric vehicle by private sector; (c) Germany is aiming for 5 million electric vehi-

cles in 20 years, with the first million achieved by 2020; (d) Spain foresees subsidies up to €6.000 in order to have 70.000 electric vehicles in two years; (e) USA are planning to achieve 1 million electric vehicles by 2015, 11.000 charging points by 2011 and subsidies up to $11.000 for purchasing an electric vehicle; (f) Korea aims to cover 10% of the world market.

Based on the subsidy programmes, notifications and operative sector, 8 million of electric and hybrid vehicles would be achieved by 2020, with millions of euros in subsidies.

Currently, in the city of Terni electric bicycles, some quadricycles (electric vehicles) and electricity driven public buses are being used. How many electric vehicles will be in Terni in the near future? That depends mostly on the subsidy programmes put in place for the purchase of vehicles; also, largely depends on how well will ASM Terni manage with the emerging market of electric vehicles.

ASM TERNI has already started techno-scientific research, experimentations in the field and analysis of distribution grid to estimate the impact caused by the electric vehicle charging stations, both public and private; the analysis and planning are being carried out for the following infrastructural adjustments of distribution grid that, in the medium–long term, are to become inevitable to satisfy the need of emerging market.

The results of the study carried out could be generalized and used as a plausible evaluation of an impact that the charging stations have on the public distribution grid managed by municipal multi-utility companies, with the related example of the network under the ASM TERNI management. Electric vehicles (EV), whether motorcycles, tricycles, quadricycles or automobiles, are overcoming two main environmental issues concerning urban and suburban areas: the air quality is increased using zero-emission vehicles and the noise is reduced to the wheel rolling noise. This represents an environmentally friendly solution for the urban and suburban mobility, with long-term benefits.

The scenario that awaits is a gradual substitution of present car stock with plugin-hybrids at first, following fully electric cars. Local municipal multi-utility enterprises will take a crucial part in the realization of the infrastructures and diffusion of electric vehicle charging stations, whether in public or private areas.

The present capacity of a fast charging is up to 80% of a battery in only 15-30 minutes. It is still far from the goal of reduced charging time to 5-10 minutes, as such short time would become competitive regarding the times to fill up a gasoline tank. Notwithstanding a current gap between the fuelling times, it is still a huge step forward from the previous charging times of 6-8 hours, which involved accumulation system and previous generation electric vehicles.

FederUtility (*Federation of Energy And Water Companies*) has carried out the opinion polls with the results that more than 70% of Italian drivers would be willing to purchase an electric vehicle, while 1 in 10 would buy it without a doubt if it was in the market; 54% of respondents requested for greater kilometrage independence and more charging points; 45% of respondents would appreciate public subsidies and 40% would like the prices of electric cars to be indifferent to the current gasoline car market prices. The percentages are in line with the ones of many other countries, and imply an electric car use expansion in the near future followed by a technological development and cost reduction.

## 6. Towards a Smart City

The evolution from Smart Grid to Smart City is a virtuous and economically sustainable process, as it involves the use of information and communication technology in the Smart Grid with resulting typical services of an Intelligent City. The mean of communication in use will be, partly carried out, broadband communication network, which serves to connect the central systems to installed devices that are connected to the electric grid. The subsequent communication network will be wireless, connected to the main network, as it is already implied for Smart Grid.

The Smart City cannot disregard the application of the system for energetic efficiency with an opportunity to analyse the data of consumption (electric power, water and gas) using a real-time monitoring tool (Smart Panel). The Smart Panel could be applied to the IT systems or already available devices (Tablet, PC, Smart phone, I-Pad,…); Smart Panel could be applied for the domestic use as well, regarding: the climate control (personalized heating), burglar alarms, management of household appliances, management of domestic electric car charging points and general home automation applications. This device will also permit an easier management of other important personalized tasks such as domestic waste sorting for recycling. Therefore, every citizen could activate a domestic waste collection service which provides an advisory information of sorting the recyclable materials according to their type. Waste management services will also have a real-time information of the waste collected and provide a tractability of the service (specifying street and house number), consequently, it will be possible to optimize the time of the service of urban solid waste collection and litter removal. The idea is to bring into existence an evolutional system “smart” of the sorted waste collection “on demand”. Upon the realization of the smart waste management, it will be

possible to apply personalised fees that will depend on day, hour and number of waste collection services received.

The Smart Panel will also monitor the consumption of water and will allow water network managing company to warn the consumers of unexpected temporary water shut-offs, in a case of any unusual consumption or sudden breakdown of service. Consumers will receive a real-time information regarding possible flooding in their area. In this way, the water resources will be saved and service quality raised, since Smart Panel will allow to communicate warnings of any breakdowns of a service directly to the network managing company. Moreover, other multimedia services will be available for the citizen, such as opening hours of venues, pharmacies, communication of the latest service failures, cultural events and announcements of public protection. These services could be either free or paid for.

Another important step in building a Smart City is the creation of electric vehicle charging stations (cycles, motorcycles and cars) having both public and private charging points, while this will spread a use of sustainable mobility and therefore will improve the environmental impact, especially considering the air quality.

Sustainable transport can be achieved contingent upon the availability of the real time information of open charging points and distributed energy cost mapping in relation to the electric grid state, its overload capacity and the state of distributed generation. Eventually, the Smart City will face an old town being transited only by electric transport, whether public or private. The development of the informative dashboards, with a display and wireless network connection, will also make the information of public utilities be accessible to the administration of the local authority and citizens.

The perspective of the project Terni Smart City obviously requires an expansion of the Smart Grid to the territory served by current electric grid and, consequently, the communication network coverage of all municipality. All of it will be implemented through the technological model development that could eventually be adapted to other local distribution grids with an available hosting service.

## Conclusion

The main purpose of this working paper is to demonstrate the Multi-utility Society managing an electric grid and making the most of gained experience,

through the work with smart metering, being ready to confront the evolution of the electric grid by creating a roadmap which passes through smart grid, demand response and electric mobility – crucial steps to the realization of Smart City. The path leading to the Smart City consists of the development of Information and Communication Technology (ICT), which must be accepted and accustomed by both sector workers and consumers. This inevitable path is neither easy nor short although backed-up by educational institutions and life-long learning. The innovative effort, affecting sector workers and customers, is bringing significant economic savings related to the scarce resources such as energy and water, and is reducing the environmental impact.

Every roadmap stage involves the experimentations that are being carried out by ASM Terni, through the pilot project, in order to acquire the right competences and necessary technology needed to face the following steps. Furthermore, this path involves a number of cooperation agreements with passive consumers, producers, public authorities and private companies, giving ASM Terni promoter's role in partnership between public and private sectors. In particular, the project FINESCE, with ASM Terni as one of the participants, is a part of the second phase in Work Program 2011-2013 called "Future Internet Public-Private Partnership" carried out under the Seventh Framework Programme (FP7) to analyse the Future Internet through the partnership between public and private sectors in different countries.

The expected outcome is the ability to take an advantage of the new infrastructures, which are required to be implemented by Multi-utilities due to the evolution of technology, in order to provide the usual services with a modern approach as well as introduce new services to the society.

The Smart City is willingly defined as an intelligent community that deals with new challenges using public Multi-utility's modern infrastructures and creating innovative services in the territory.

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## FUTURE IS T-SMART

### Summary

The English word *"smart"* evokes a lot of stimulating and positive meanings concerning brains. This word is utilised for identifying advanced and innovative high-tech projects, where Information Communication Technologies (ICT) play the core role. The project named *Terni Smart-City Project (T-SMART)* wants to get the town of Terni as a experimental laboratory for new technologies in production and distribution of energy, in alternative mobility, in services for consumers and citizens. It is an innovative and global planning asking the convinced and active participation of all the members of Society.

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