FEDERAZIONE NAZIONALE IMPRESE ELETTROTECNICHE ED ELETTRONICHE

CONFINDUSTRIA

ANIE ENERGIA

ANIE – ENERGY STORAGE SYSTEMS GROUP

Position paper on the role of Electrochemical Storage Systems in Electrical Systems

November 2012

Index

Executive Summary

The world of electricity is going through some major changes, which began taking place more than a decade ago, when the sector was liberalized. The number of plants operated from renewable sources then started growing, since production needed to become more sustainable as did the use of electricity, back in time the engine of industrial society and nowadays of the digital one.

The non-programmability of plants run from renewable sources, e.g. photovoltaic and wind energy, and their widespread availability on medium and low voltage distribution grids are currently leading to the adjustment of planning and management standards of power electrical systems. Moreover, the involvement of passive, active and shared consumption in running the grids is constantly increasing.

At the same time, there has been a quick technological development of energy electrochemical storage systems, based on widespread and sound technologies, such as those lithium or sodium-based, which were able to effectively meet the new needs. These systems therefore favor the network integration of renewable sources, photovoltaic and wind energy, with traditional approaches and technological solutions.

The National Energy Strategy paves the way for a new stage of the country's electrical infrastructure and this means relying on a new tool that, together with renowned systems and components, widens the range of solutions aimed at meeting the new conditions of generation, transmission, distribution and consumption.

Europe, on a global scale, and Italy, at a European level, are on the forefront to pursue a more environmentally sustainable electricity production, which can be obtained by banking more on renewable sources; Italy and Europe are therefore increasingly turn the attention to the use of electrochemical storage systems. These may also play an important role by transmitting and distributing energy more efficiently, therefore setting a new paradigm as far as widespread generation and self-consumption are concerned.

The core of electrochemical storage systems is the shifting from a small-parceled production linked to mock-up projects to a large-scale production, resulting in a sudden cost decrease.

Furthermore, research and development aiming at finding efficient and reliable storage technological solutions have to carry on and a considerable effort is needed, for electricity market operators to gain real advantages.

AEEG, the Italian Authority for Electricity and Gas, has launched an initiative whose purpose is for those managing transmission and distribution networks to support pilot projects concerning storage systems and envisaging higher remuneration for the investment made. The initiative is one of the possible solutions to further support research and development, which are essential to seek economically competitive and efficient technical solutions.

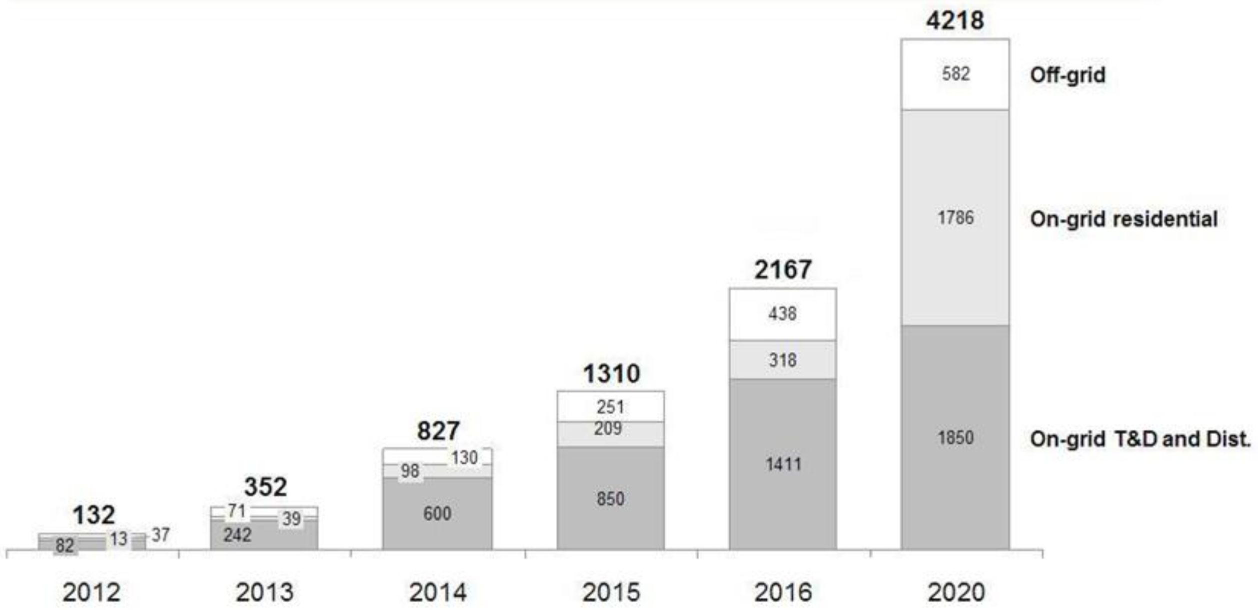
Similarly, new structural ad hoc funds (such as POIN energia) and funds allocated for research and technological development (both at a national and European level) ought to be channeled to re-program current measures (those still having unused capacity) and also to introduce new ones for the 2014-2020 programming period.

Other possible ways may be that of a direct or indirect stimulus of generating energy from renewable sources alongside self-consumption (be it residential or industrial).

What has just been said aims at fostering the Italian supply chain by coordinating energy and industrial policies, alongside the attraction of foreign investments.

Here below, the trade figures trend expected for the 2012-2020 period:

2012-2020 Storage system market according to the application used:



Source: Boston Consulting Group

1. The evolution of the Italian and European electrical industries

Shortly after World War II, the Italian motorway network, which was the pride of the nation before the conflict began, had a length of 311 kilometers. Twenty years later, thanks to the investments made by ANAS and Iri, it was further extended, reaching a length of 5.600 kilometers. Similarly, department stores took over during the 80s and 90s. These two events fostered an ailing economy and stimulated the Italian manufacturing industry.

Things changed when the new century began. Shortly before the Internet era, Italy boasted one of the most important telecommunication companies worldwide, Telecom Italia, which was also ranked first at a European level, as far as its scope and trade area are concerned. However, after a decade of small-scale policies and management, the company could not keep up with the so-called digital Darwinism, giving birth to Apple, Google, Amazon and Cisco. The Italian information highway was therefore never born.

Fifteen years later, things are about to change once again. The world economy turns green and that is due to a series of factors, among which the new environmental duties and the need to have a cheaper and more secure access to electricity grids. The most developed western countries and the main developing economies are firmly betting on the Green Economy, deeming it essential for a much-needed sustainable development.

At the dawn of the Third Industrial Revolution, Italy is again in a favorable position to play its part in an important development process. There is still much to do, but major changes have already taken place, bringing about significant results. That is of paramount importance for Italy, which definitely needs to rely on renewable sources.

The Italian energy system is already facing radical changes. The increasing use of renewables has led to important environmental and economic gains, but also to market distortions, additional costs on transmission and dispatching systems and an uncertain impact on the industrial chain.

Even though Italy began its engagement earlier than other European countries, the pursuit of 20-20-20 objectives is being carried out unevenly since it has been more focused on RES and CO2 rather than banking on energy efficiency and saving, to the detriment of the system balance and infrastructural investments.

The traditional generation system is going through a phase, which is marked by overcapacity (owing to post-liberalization considerable investments, the decrease in the demand and the priority given to renewables), eventually having a major impact on spark spreads. The electricity market cannot always warn the investors as far as prices and risks are concerned.

At the same time, as the Gas market has not been liberalized, the two sectors cannot work synergistically, therefore leading to an imbalance, when considering the most advanced European markets. International and national transmission networks, which have always been considered well-advanced and by all means secure, turn out to be vulnerable because of congestions, absorption of imbalances, dispatching costs, security, and difficulty in implementing new works. Moreover, the outbreak of shared generation has caused certain distress because passive distribution networks have had to become active and carry out dispatching tasks within their remit.

The positive effects on energy costs deriving from the liberalization have been offset by the increased systemic cost, eventually weighing on end users. All across Europe, companies have therefore to face higher energy costs, weakening the competitiveness of the Italian productive system.

These issues have been clear since the partial compliance with the 2020 low carbon economy targets and trying to reach the medium and long-term targets might cause the system to collapse, if no radical change is envisaged.

2. The role of electricity storage systems on the reference industry value chain: Production, Transmission, Distribution and Consumption

Every stakeholder in the sector agrees that tackling the abovementioned challenges is a priority. All technological branches in the chain need to chip in and, beyond traditional components, stakeholders think that great quantities of energy need storing, in order for generation and dispatching to be decoupled.

Battery producers are part of the change, drawn by challenges coming from the automotive industry, with electric vehicles on the rise, and from major energy consumers, whose aim is to find better solutions for their systems to work more efficiently, for energy consumption to be reduced but also for costs to be lower in relation to new directives.

The storage system manufacturing sector aspires to reach the needed scale economies by overlapping the demands coming from three key sectors (automotive, consumers and energy governing bodies). The sector has thus launched a massive investment plan for research and development, in order to select suitable technologies to be enhanced, made more reliable and cost-efficient.

Another key element favoring technology research and the amount necessary to implement solutions is the growing attention paid to global-scale storage solutions, tackling issues such as low power quality, electrification of rural areas, sloppy energy supply and programs envisaging massive generation from renewable sources.

As for the Italian electricity grid, here are the most promising employment areas concerning storage systems:

- **PRODUCTION**

  Electrochemical storage systems of the new electricity sector may draw interest in relation to medium and large-sized generation plants fueled by either traditional or renewable sources.

  In the first case, the growing production share coming from non-programmable renewables and the decrease of consumption (in many countries owing to the economic crisis) lead to a more flexible use of major production plants, used earlier for basic and scarcely modulated production.

  The most important structural and production level change these plants are called upon, especially combined cycle gas power stations, is due to the events affecting energy markets but also dispatching services. Owners of transmission system are widely and increasingly using these services, having to integrate a growingly rising share of non-programmable renewables in electricity systems. Using storage systems in traditional production plants allows to partially decouple the work of the station from the grid needs, relieving the equipment from overwork and optimizing the work of the station, which nowadays is essential.

What complements the flexibilization of traditional plants is the increased programmability of plants propelled by renewable sources: here, storage systems may be an interesting solution. They may render production more balanced, allowing the grid provider to resort to dispatching services less often and may contribute to the grid work by controlling its voltage and frequency. Finally, production time shift may allow to store energy when the grid is congested or prices are lower and release it when conditions are more favorable or when the energy value increases. This could lead to a more fluid energy market.

Storage systems thus favor the integration of small and medium-sized plant production into larger production and storage systems, which can also be programmed.

- **TRANSMISSION**

  As for this sector, the grid owners, and the Italian in particular, have found in electrochemical storage systems an interesting tool both to enhance the electricity infrastructure and to run the system in real time. Plants which are propelled by renewable sources and are at the same time afferent to the sub-transmission system (especially wind farms) are often located in areas where the grid is not much developed and may therefore encounter difficulties in taking in energy in the event of high source availability. This usually occurs few times in a year, hence the low development and use of the grid. Consequently, the Transmission System Operator (TSO) believes that placing storage systems along the electrical backbone in those stations with a strong presence of plants from renewables, can solve the problem in the short/medium term, waiting for the grid to be enhanced, which usually requires much time. The very same plants may also provide further services at production plants.

  An indirect benefit storage systems can bring about is the chance to flexibly manage the investment deferral, making choices according to priorities (be them time, costs or the importance of the event).

- **DISTRIBUTION**

  Distribution System Operators (DSO) are also showing their interest in storage systems. The considerable growth of Distributed Generation (DG), usually from non-programmable renewable sources (NPRS) and linked to medium and low voltage grids, is leading DSO to change their planning, development and usage parameters of the grid, aiming at optimizing the DG which can potentially be linked, considering the existing structures. This will then lead to the improvement of the service quality, performance and reliability; competent authorities closely monitor these standards. Using electrochemical storage systems may be a sustainable alternative to the traditional enhancement of the grid, which cannot be backed economically owing to the outburst of connecting DG, and it may also provide useful services to run the latter, also helping DSO becoming the grid's "local dispatchers". The best collocation for electrochemical storage systems in distribution grids is at the moment a debating point: putting them on the backbone would bring local benefits, while placing them in Primary Substations would allow DSO to better monitor active and reactive power flows, which are exchanged with the high voltage primary grid, implementing dispatching orders coming from TSO when necessary, or adjust the exchange profile to stick to expected values.

- **CONSUMPTION**

  Many of the abovementioned grid services can be provided by a storage system installed either in a TSO/DSO's plant or at the user's, be it active, passive or mixed (the so called "prosumer"). The future of both development models does hinge on the evolution of related laws, norms and rules. The Authority for Electricity and Gas is trying to regulate the investments made by transmission and distribution grid owners in storage systems, aiming at allowing pilot projects to be developed, in order to eventually define the gains these systems can bring, while envisaging a future regulation. Recent measures and incentives favor the installation of storage systems in plants and entrust the Italian Authority for Electricity and Gas with the task of defining how plants owners can use the systems both to improve the management of plants and to answer modulation signals coming from grid owners. Improvement in grid management can be linked to specific incentives, like those provided by the Ministry of Economic Development in the recent DM V (Rulemaking n. 5) of July 2012 (known as Quinto Conto Energia). In general, storage systems not only allow a more flexible management of the user's plant (be it active, passive or mixed) but they also allow it to be part of the grid management, by supplying owners through methods which will be defined by the Authority.

3. The impact of storage systems on the chain of electrical components and on system integrators.

What has to be clear is that when referring to storage systems, not only is electrochemical storage equipment taken into consideration but the whole system is, meaning all the electrical, electronic and mechanic components needed to connect batteries to the grid and make it work, as stated earlier.

Components can be summarized as follows:

- Electromechanical equipment to connect the system components among themselves and to the grid: motor and signal cables, protection and operation equipment, switchboard and connected accessories etc.
- AC/DC conversion equipment: inverter with control logic developed to take full advantage of the battery performance in relation to the expected use (e.g. in terms of charge/discharge cycles and respective speed) while respecting operational duties and to provide the grid service necessary to set the frequency and the voltage requested by TSO/DSO.
- Systems monitoring batteries and storage devices: electrochemical storage cells have to be constantly monitored to verify that function parameters (such as temperature) stay within the technical limits, as established by the builder, and to pinpoint any damaged part in order to rapidly intervene and, if necessary, switch off the device. As for the connection to the grid, Balance Of System (BOS) can remotely monitor the state of the equipment, to guarantee immediate intervention, if needed, and to always ensure a reliable supply.
- Systems managing the storage device: computer systems need to be developed, for the storage device to work properly. Algorithms have to be defined, for the storage to achieve the expected targets. If the storage system is connected to public transmission or distribution grids, managing systems have to be properly integrated into the existing monitoring centers. There, most information concerning the proper functioning of the electrical storage can be found; the impact of the storage on the grid has also to be monitored, according to standards in force. Similarly, the installation of an electrochemical storage system at a private user's entails the supply of the same monitoring software, possibly integrated into the already existing supervision system.

The role played by BOS can by all means affect the value of the whole system, also having consequences on the part of chain that is not closely linked to electrochemical storage.

The range of operators involved is even wider, if we consider that storage systems can be used for small residential systems but also for large grids and that different operators are involved, according to the case.

What emerges is that the development of electrical storage integrated solutions not only entails opportunities for electrochemistry builders but also interesting openings for those operating in electro-mechanics. They would not be called upon only to supply components, but also to pursue, through financial support, their own economic sustainability.

There is a debate going on at a European level trying to tell if it should be easier for storage operators to enter the sector, meaning that certain companies will be able to provide energy storage services to any interested sector and for any kind of use.

4. Opportunities for the national economic system in terms of keeping its technological leadership in the sector and of the branch's industrial development

As the electrical sector is going through major changes, our industrial branch faces uncertainty; the economy is characterized by low growth or, worse, by the decline of the national market. What is more, public expenditure is being reduced and regulation criteria are not clearly established. The electronics and electro-technics order book shows an overall decrease (-4,3%), especially in those branches which have been hit hard by the domestic consumption decline (e.g. house and professional appliances). On the contrary, renewables and the Transmission and Distribution branches recorded a positive trend in 2011 (+ 11,1% and 9,5% respectively), thanks to the investment plans carried out by Terna and Enel. Domestic demand is being affected by a constant decline; that is why only foreign markets, which currently guarantee nearly 50% of the whole turnover, will provide growth opportunities. The path to take is that of innovating the domestic market to acquire the necessary know-how and then be competitive abroad.

In the last few years, non-traditional activities (storage systems and non-regulated activities) are gaining weight as far as the need to renovate the national Transmission and Distribution grid is concerned. In this field, the development plans carried out by Terna and Enel may lead to the creation of a more efficient electricity market and a sustained industrial development.

That being considered, as underlined by ENEA in its COGNITIVE SURVEY ON THE NATIONAL ENERGY STRATEGY and by the Ministry of Economic Development in its consultation draft of the NEW NATIONAL ENERGY STRATEGY, the development of renewables is a necessary step Italy has to take. Even though the incentives created in recent past have surely affected consumers' bills, they have also complied with European objectives and made a contribution in redefining the national energy mix.

In 2010, Italy invested nearly 14 billion euros in the photovoltaic sector (ranking fourth globally), also recording the most significant growth rate (+136%) worldwide. In 2011, it ranked first. Despite that, the sector's balance of trade now records a concerning 16 billion euro loss ratio owing to the lack of planning and, consequently, to the national industry's inability to respond technologically. Even though there has been an increase in the number of operators in the sector, Italian companies have rather focused on what happens in the late stages of the chain and they are also those having a smaller profit margin. Moreover, the share of resources allocated to technological innovation and the development of manufacturing capacity has so far been modest. There is a very articulated and increasingly global market linked to renewables; an increase in the national manufacturing capacity, especially in its most technologically advanced parts, would have created development opportunities also in terms of employment, because of the constant turnover generated by foreign markets.

Now that policies on renewables begin having significant effects (and also many issues) on the global electricity system, the role of storage systems becomes pivotal; non-traditional generation and the abovementioned sectors will have to positively contribute to set a balance between electricity demand and supply (considering consumption and the management of peaks). Even though there are many technologies of electrochemical storage available today, the intrinsic barriers of a newly born market thwart their full adoption.

That is why countries like the United States or Germany (which are very innovative in terms of renewables) have launched development plans banking on electrical storage technologies as an integral part of the production process. Similarly, here in Italy there is the need to develop policies able to turn investments into social and economic gains; they can be achieved through dedicated normative tools (temporarily market-oriented) and an adequate temporary incentive plan for investments, alongside a number of experimental initiatives.

An effort has to be taken to support and guide industrial investments with a plan promoting research for new technologies and materials. ANIE enterprises currently invest more than 4% of their annual turnover, much more than the ratio between the national average expenditure and the GDP, which is 1,27%, and the European average, which is 2% (data provided by ISTAT and ANIE in 2009). This would allow a further development of high-tech products and systems.

Adequate answers therefore have to be provided by the National Energy Strategy. ANIE Storage Systems Group agrees with the objectives and the strategic guidelines of the recently published consultation draft. However, improvements can be made, especially as far as the integration of renewables in concerned. Limited incentives cannot tackle the issue concerning the congestion of grids and would jeopardize the achievement of the renewables strategic objective, that is 23% of total consumption and 38% of electricity consumption.

As for measures on the medium term (5 years if thinking in terms of 2020), it is necessary to enhance transmission grids. However, hoping that sites that have not been opened yet will be closed in such a short period would be misleading.

We also think that long-term measures ought to be defined more clearly. If “storage capacity is to be enhanced”, relying on batteries “also from an industrial point of view”, then measures and rules following experimental activities ought to be defined. Even though it is agreeable that cautiousness and experimentation have to be put to the fore in the early period, the rapid evolution of the global market has to be taken into consideration. So do the dynamics of every industrial branch, needing 6-8 years to acquire the competitiveness and maturity to carry out a large-scale development. The outlined strategy should also be complemented with guidelines for storage systems used in household and industrial environments.

Tackling these issues means investing in the battery industrial development, favoring an Italian branch banking on the competences available in the country. We then wish a deep and shared reflection on how to make storage systems pivotal and efficient. These are the true breakthroughs in the field of electrical components, able to restrain detachments, which may prove to be detrimental both to the electrical system and the consumers’ bills.

That is why we suggest the large-scale experimentation plan be pushed through and expanded (starting from the activities already planned by Enel and Terna), along with measures supporting research. At the same time, a storage development plan is to be launched, considering the grid's needs and the cost of solutions, and aiming at increasing generation from renewable sources.

Italy is once again in a favorable position to take on economic and infrastructural changes and revolution has not to be imported this time, as opposed to what happened in the field of telecommunications. The global Smart Grid was born in Italy 15 years ago, brought about by Enel's TELEGESTORE plan, which today still counts 50% of the smart meters installed along the global electricity grid. Traditional production is by all means to be safeguarded, being the backbone of the country's capacity to generate electricity today and in the future, but it has to be combined with rising sectors (e.g. storage) and prominent ones (e.g. generation from renewables), therefore favoring the development of new industrial braches and unburdening the Italian electricity bills.

5. The need to plan and regulate

The need to plan investments in the field of storage systems and to define a stable normative framework involves both the regulated and the electromechanical industry. That is why both grid owners and AEEG have developed plans and put forward interesting proposals, which will be here shortly described in order to have a clear picture of the state of the art.

Terna's interest in using storage systems was outlined for the first time in a dedicated file[1,] which was attached to the 2011 Development Plan. It is here underlined how the rapid growth of plants fueled by NPRS has led to changing the parameters of grid management and the interest in storage systems, whose benefits are hereby summarized:

- Putting and end to grid congestion: storage systems allow to store energy while production is high (e.g. from renewable sources in areas where demand is low and grid is weak), therefore preventing congestion from happening, the structure from being adjusted and production from being modulated. The energy is then released when solar and wind sources struggle to cope.
- "Peak shaving" mode: storage systems are able to level off consumption peaks by storing energy when there is low demand and generation plants operate less efficiently (idle mode). The energy is then released when demand is higher and less reliable and possibly more expensive plants are kept shut.
- Reserve supply for the electrical system: storage systems can efficiently contribute to satisfy the reserve demand of the electrical system in circumstances when it has to be used. Owing to the speed at which energy is withdrawn and input into the grid, storage systems are the most efficient tool to carry out this task and can be integrated into the protection scheme of the national electrical system.
- Supplying frequency primary regulation capacity and reserve trade-off to the national electrical system: if properly integrated into regulation systems, storage devices can provide frequency primary regulation, performing better than traditional plants. Storage systems also provide trade-off reserve since they respond much quicker than most of generation plants in terms of energy withdrawal and input. All this is needed to make up for the input intermittence which characterizes wind energy production and charging ramps at night, when photovoltaic plants cease to work.

[1] Terna, "2011 Development Plan" – Supplementary file on electricity widespreas storage systems", available on www.terna.it

Terna pinpoints the following positive features of electrochemical storage systems:

- High modularity guaranteeing an easy installation and a flexible use
- Little completion time, if compared to other kinds of storage systems (e.g. pumped-storage hydroelectric power stations)
- They can be placed all the grid-wide, also near the numerous connection points of plants from renewable sources, inside or next to existing power stations and a reduced environmental impact, being these systems removable.

Terna carried out the first survey when the document was drafted, the purpose being evaluating the grid needs, in order to install the systems. The overall capacity was approximately 130 MW, with an estimated gain of 230 GWh coming from avoiding modulating energy from renewable sources and 410 GWh from avoiding reserve supply on the MSD. In the attachment, you can see the 150 kV backbones in detail; here, Terna plans on installing storage systems in the short or medium term.

In its 2012 Development Plan, Terna states once again that the widespread storage systems aim at improving and maximizing the service of the national transmission grid. There will be no need, then, to build new overhead power lines, which would be used exclusively when simultaneous peaks from NPRS take place. The minimum storage capacity to drastically reduce local congestions and compensate the National Energy Strategy's small primary regulation goes up to 240 MW.

In the field of regulation, as stated by AEEG's ARG/el 199/11 resolution, in order to propel pilot projects to experiment storage systems, Terna launched "Storage Lab". It is a pilot project which will be developed up until 2015 and whose purpose is to maximize benefits deriving from the installation of state-of-the-art storage systems on the Italian grid. Here are its tenets:

- Reduction of risks deriving from the adoption of new and still undeveloped technologies, with a limited commercial history;
- Reduction of downstream costs, therefore benefiting the Italian electricity system, especially integrating plants from NPRS;
- Maximizing benefits by developing smart grid applications, allowing the integration with the grid's dynamic management;
- Favoring the research, development and implementation of these technologies and storage solutions on Italian soil, both by local and international players.

As for distribution systems, Enel Distribuzione has in many occasions shown interest in installing storage systems on its distribution grids, in order to tackle new challenges deriving from the massive penetration of distributed generation, the mitigation of intermittent production of NPRS and the local support to the distribution electrical system. In Enel Distribuzione's vision, storage systems could actually replace more expensive interventions, e.g. when the grid is overcharged only in certain parts of the day. In its own Development Plan[2], Enel states that storage systems are likely to be tested both on MV (Medium Voltage) and the PS (Primary Substations) grids; this will be carried out by implementing pilot experimentations within Smart Grid projects, e.g. the Isernia Project (officially recognized by the Authority for Electricity and Gas) which operates the first electrochemical storage device in Italy. In 2012, the Enel investment plan entails the installation of the first four PS systems in the following plants:

- PS Ginosa Marina (Apulia)
- PS Cammarata (Calabria)
- PS Dirillo (Sicily)
- Ventotene

In the technical attachment, you can find more sites chosen by Enel Distribuzione to install storage systems.

From a legislative point of view, these kinds of interventions can be summarized as follows:

- Article 17 of Legislative Decree 28/11[3] states that the owner of the national transmission system may include in its Development Plan "electricity storage systems aimed at facilitating the dispatching of non-programmable plants";
- Article 36, clause 4, of the Legislative Decree 93/11[4] states that "the owner of the national transmission system may set up and run electricity widespread storage systems through batteries" and that these systems "may be set up and run also by the owners of the distribution system";

The recent DM V Conto Energia[5] states at article 11, clause 1, that "in order to guarantee that photovoltaics development abides by the security of the electricity system, AEEG, ensuring the coordination with similar measures dealing with non-photovoltaic renewables and with measures established at articles 17 and 18 of Legislative Decree 28 of 2011, defines what follows:

---

[2] Enel Distribuzione, "Annual and Multi-year Development Plan of Infrastructures by Enel Distribuzione Ltd. 2012-2014", available on the website www.enel.it.

[3] Leg. Dec. 28 of 3rd March 2011, "Implementation of Directive 2009/28/CE on the promotion of energy from renewable sources, modifying and then repealing Directives 2001/77/CE and 2003/30/CE", Gazzetta Ufficiale n.71, 28th March 2011.

[4] Leg. Dec. 93 1st June 2011, "Implementation of Directives 2009/72/CE, 2009/73/CE and 2008/92/CE concerning common rules for the electricity and natural gas internal market and a common procedure on price transparency for industrial end consumers and repeal of Directives 2003/54/CE and 2003/55/CE", Gazzetta Ufficiale n.148, 28th June 2011.

[5] Decree of 5th July 2012, "Implementation of article 25 of Leg. Dec. n.28 of 3rd March 2011, concerning electricity production in solar photovoltaic plants (known as Quinto Conto Energia)", SO n.143 of the Serie Generale n.159 of the 10th July 2012 Gazzetta Ufficiale.

a) ….
b) ….
c) How the parties involved may use storage systems integrated with inverters, in order to enhance the management of energy produced and to store the production of plants if, after implementing what is described in the previous point, detachment or modulation signals happen to be sent;
d) How grid owners can make storage capacity near PS available to interested parties, also as an alternative to the previous solution.

AEEG has in many occasions dealt with storage systems, both pumped and electrochemical, in recommendation and resolution documents.

For example, document PAS 21/11[6] states that in order to put an end to the real congestion of grids, especially along the Apennines, which are characterized by a strong presence of wind farms, there is the need to "…develop electrical grids and, at the same time, discussing the creation of storage systems (especially pumped-storage) able to best profit from existing grids". The document also states that "in certain cases, the grid development may not be the most effective solution to manage electricity production from NPRS. For instance, if production revs up in certain seasons or peaks are pinpointed in certain hours of the day, creating new grids may not be the best solution. Instead, the grid involved and the flexibility of the generation system could be better exploited, modulating production from NPRS, setting up storage systems (especially pumped-storage) or systems able to dynamically observe and regulate the grids".

As far as regulation is concerned, TIT's[7] clauses 12.5 and 22.5, regarding investments for distribution and transmission services respectively, state that investing in storage systems ought to lead to an increase in the invested capital's remuneration rate (2% for 12 years), whereas these investments fall within the scope of the pilot projects according to the methods and parameters provided for by articles 13 and 24 respectively of TIT. The experimentation of possible solutions concerning storage systems installed on transition and distribution grids, as provided for by articles 13 and 24, aims at acquiring information on technologies, costs, benefits, setting, ideal placement and working methods of the abovementioned systems. The latter are tested before defining a regulatory framework in line with a possible introduction of storage systems in electricity transmission and distribution grids.

[6] Authority for Electricity and Gas, document PAS 21/11, "Remarks by the Authority for Electricity and Gas concerning the state of electricity and natural gas markets and their difficulties – Instruments proposed to the Parliament and to the Government with a view to the definition of a national energy policy",

[7] Authority for Electricity and Gas, "Integrated Text on the Authority's instruction concerning electricity transmission and distribution services – Regulation period 2012 – 2015", Attachment A to resolution ARG/elt 199/11

AEEG has for the first time defined the process aimed at selecting pilot projects concerning storage systems by adopting resolution 288/2012/R/EEL[8]. Considering what has been stated so far, AEEG declares that "there is currently a limited number of technologies for Storage Systems (SS) that have already been commercialized, whilst some technological solutions are being developed, therefore entailing a "technological risk"; in particular, the main technical parameters of the systems (e.g. the number of charge/discharge cycles, their performance and its variation in the years) and the unit costs are not to be considered reliable as of now; …if SS are installed on a large scale by market operators with no prior experimentation on a small scale, then high costs may arise and may not be later recovered". Furthermore, "the SS can carry out dispatching activities of non-programmable production plants, such as the ones from renewable sources and, more generally, they can potentially provide grid services; …there are many benefits the installation of storage systems on transmission and distribution grids can bring; these benefits are really diverse, therefore they cannot be either quantified or added up since it all comes down to the methods used by the very same systems". These are the minimum requirements that AEEG deem necessary for those SS on transmission grids aspiring to take advantage of the incentives offered:

a) They have to be included in the Development Plan;

b) They have to be removable;

c) They have to input electricity coming from NPRS, within the necessary grid improvement plans;

d) They have to complement a grid dynamic monitoring system;

e) They have to be set to store the electricity which is produced and cannot be absorbed and to immediately regulate frequency when no other intervention is possible.

With reference to Terna's proposal PdS 2012, stating that 240 MW is the minimum functional value to drastically reduce congestions at a local level, AEEG believes that the testing phase, aimed at acquiring the necessary information on SS while being cost-effective, ought to precede the extensive implementation of the SS themselves.

The definition of the selection process for pilot projects to be given incentives (art. 13 of TIT), will be preceded by a consultation phase; this is due both to the recent evolution of dispatching regulation concerning NPRS (resolution 281/2012/R/efr[9]) and to the need to better define how SS are introduced on the transmission grid, as far as the structure and technological options are concerned.

[8] Authority for Electricity and Gas, Resolution 288/2012/R/EEL, "Procedure and selection criteria for pilot projects concerning storage systems and contingent investments", 12th July 2012

[9] Authority for Electricity and Gas, Resolution 281/2012/R7erf, "Review of the electricity dispatching service for electricity production units propelled by non-programmable renewable sources, 5th July 2012.

6. ANIE's operating proposals and next steps to take

A) ANIE Storage Systems Group hopes that the initiative carried out by AEEG on supporting experimentation will follow through and that this testing phase will take the time necessary in order to fully evaluate technology. The latter consists of two main components: the first is linked to electrochemical storage while the second deals with grid connection through static conversion. If the testing phase lasted too much, however, the industrial branch could not develop properly.

B) AEEG and competent ministries shall consider every measure aimed at supporting the introduction of electrochemical storage technologies in the national electrical system and consequently the rising industrial branch. Regulatory tools are needed (in a temporary market-oriented regimen) and so is a new system of incentives, which has to be limited in time and address trial initiatives only. ANIE Storage Systems Group therefore expects a smooth and constructive discussion with the technical structures of the Ministry of Economic Development, AEEG, grid operators and of the main research centers involved (starting from ENEA), also in the wake of measures which are being introduced in those European countries, like Germany, which face similar issues.

C) It would also be very useful to reprogram and draw on measures of the European and national planning still in force (period 2007-2013) and include electrochemical storage systems in the planning which is currently being defined (period 2014-2020). Anie Storage Systems Group is willing to table a technical discussion with delegates from the Ministry of Economic Development and from the Ministry for Territorial Cohesion of the Council Presidency.

D) It is essential to make an effort to complement industrial investments with a plan supporting the research of new electrochemical storage technologies and electronic systems monitoring and converting energy. The whole sector then hopes that attention will be paid to the role of storage systems in evaluating the projects funded through the decree for "the enhancement and development of national technological clusters" with reference to "Technology for Smart Communities" and "Energy" branches. Further national and regional measures are hoped for, together with support coming from the Italian Government and the Ministry of Education and Research in defining European programs to fund research ad technological development. Also on this point, ANIE Storage Systems Group is available for a technical debate aimed at taking adequate measures and actions at a European level, alongside foreign industrial associations.

E) ANIE encourages policy-makers not to neglect the use of storage systems also in the active, passive and shared consumption, also if it is already connected to the energy distribution grid. The Ministry for Economic Development, through the DM V of July 2012 (known as Quinto Conto Energia) has thus entrusted AEEG with the task of defining how stakeholders can use storage systems to improve the management of the energy produced. ANIE deems it necessary to carry out a shared accurate assessment on the benefits brought about by a widespread installation of storage systems and also hopes for a timely intervention by AEEG and all the institutions involved, in order for testing to start in private plants.

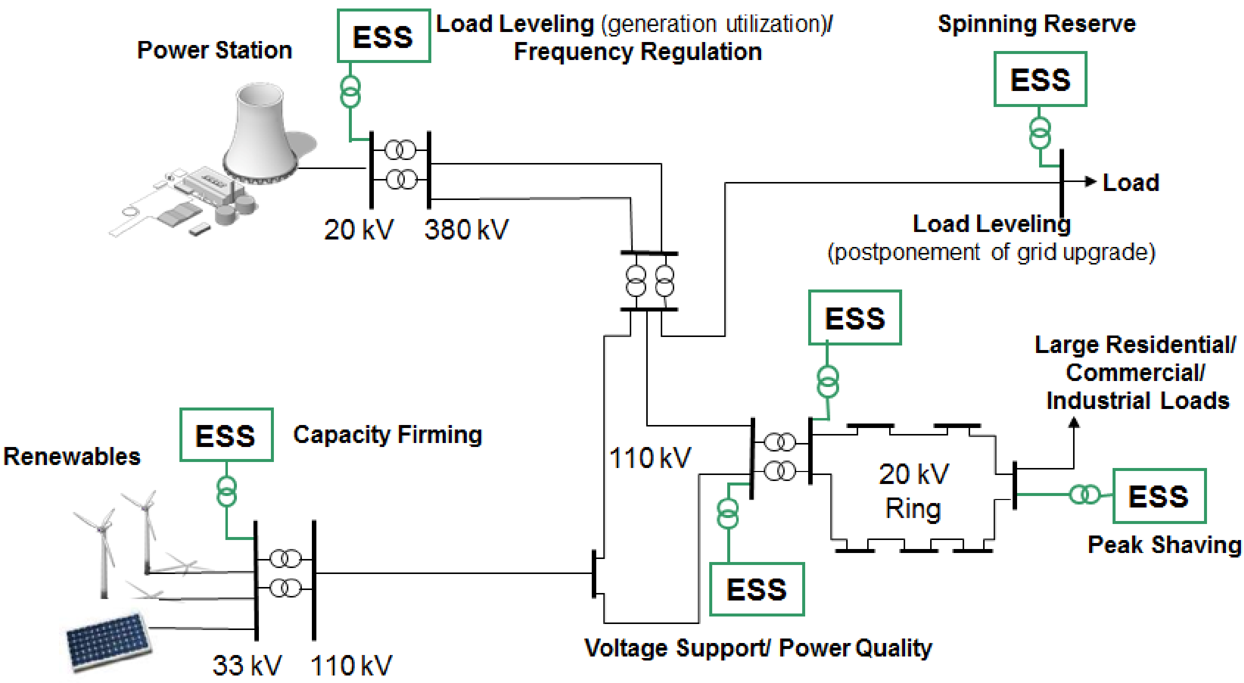
F) ANIE reminds policy-makers that storage systems are useful also for small electrical grids, which are not connected to the national line for geographical reasons. These cases also ought to be accurately analyzed to evaluate contingent benefits and support through adequate research programs.

G) In order to create a competitive market leading to economically sustainable technological solutions, it is important to complete the existing normative framework. By doing so, new private operators will enter the field and provide services concerning grid flexibility.

H) With reference to resolution ARG/elt 160/11 "Starting the process to create measures concerning the regulation of dispatching service", and the need to evaluate a more general review of dispatching, also considering the new rapidly evolving structural and market context and, consequently, the need for a more flexible system, ANIE Storage Group asks that the reviewing process deal with storage systems connected to transmission and distribution grids, and introduce the necessary adjustments for these devices to supply dispatching services.

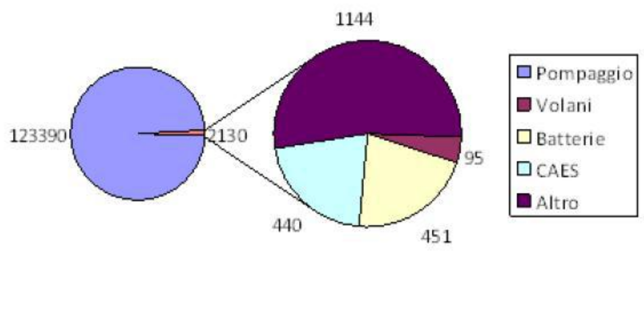
Attachment A: Brief analysis on the state of the art of electrochemical storage technologies

Storage Systems – Applications:

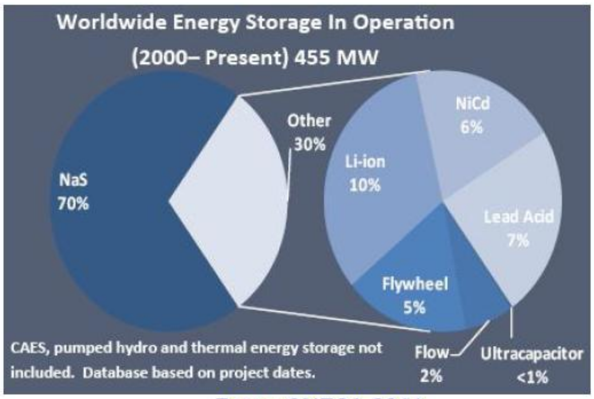


The picture shows the wide range of opportunities concerning the application of battery energy storage systems (BESS) and their possible location in the global electrical system: from generation plants (traditional and RES) to transmission and distribution and to end users. Even though the application of a BESS has to meet specific requirements and "local" needs, its connection to the grid allows it to make other contributions. The issue has to be tackled globally and needs regulating; by doing so, favoritisms and consequent disadvantages will be avoided and global economic synergies will be able to help the country develop. ANIE Storage Systems Group reiterates its availability to contribute to this approach.

The charts below show data of late 2011 concerning storage systems worldwide:



Fonte: STRATEGEN Consulting 2011



Fonte: CNESA 2011

The most used is the hydroelectric pumped storage: 123 GW

The other kinds amount to 2,13 GW, among which:

450 MW of batteries, of which 70% NaS

440 MW of CAES

95 MW of fly-wheels

Source: RSE

The table below compares storage systems in main applications:

APPLICAZIONE	Idro	CAES	Na/S	Na/NiCl	Li/ion	Ni/Cd	Ni/MH	Pb/acido	Redox	Volani	SC
Time-shift	🟢	🟢	🟢	🟢	🟡	🟡	🟡	🟢	🟢	🔴	🔴
Integrazione rinnovabili (Profilo prevedibile)	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴
Differimento investimenti rete	🟢	🟡	🟢	🟢	🟢	🟡	🟡	🟡	🟢	🔴	🔴
Regolazione primaria	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴
Regolazione secondaria	🟢	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🔴	🔴
Regolazione terziaria (Riserva pronta)	🟢	🟢	🟢	🟢	🟢	🟡	🟡	🟢	🟢	🔴	🔴
Riaccensione sistema elettrico	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🔴	🔴
Supporto di tensione	🟡	🟡	🟢	🟢	🟢	🟢	🟢	🟢	🟡	🟢	🟢
Qualità del servizio (power quality)	🔴	🔴	🟡	🔴	🟡	🟡	🔴	🟡	🟡	🟢	🟢

🟢 Sistema adatto all'applicazione 🟡 Sistema meno adatto degli altri all'applicazione 🔴 Sistema non adatto all'applicazione

Source: RSE

Attachment B: information on Terna's and Enel Distribuzione's development plans concerning the installation of storage systems

According to Terna, the following 150 kV backbones in southern Italy are to be considered critical:

- Campobasso – Benevento 2 – Volturara – Celle San Vito: along the 150 kV lines Benevento 2 – Foiano – Volturara and Benevento 2 – Montefalcone – Celle S.Vito there are up to 640 MW of wind farms installed and further 70 MW may start working in the next few years. The line is congested 3000 h/year and, even though interventions have been made, for wind farms not to resort to modulation, nearly 100 GWh were not produced on these lines in 2011. According to Terna, this is due because when wind farms were allowed, no authorization was given to carry out maintenance until the Single Authorization (Leg. Dec. 387/03) was approved[10]. In order to solve these issues, Terna has planned a number of enhancement interventions, together with the installation of storage systems, to take place in 2013/2014.

- Benevento 2 – Montecorvino: there are approximately 830 MW of wind farms installed, with a potential further development of about 300 MW: as for photovoltaics, 30 MW are already installed and in the short-term further 130 MW will be added. The line is congested 3000 h/year, entailing specific interventions and modulation of wind production amounting to 80 GWh in 2011. Also in this case, alongside the already carried out improvements (the connection Bisaccia SE 380 kV to 150 kV line Bisaccia – Calitri was completed in October 2011 while limitations of transport capacity have already been lifted on the lines Benevento – Industriale – Ariano Irpino – Flumeri – Lacedonia – Bisaccia – Calitri – Calabritto – Contursi), Terna deems it necessary to install storage systems in the years 2013/2014.

- Foggia – Lucera – Andria: in the Foggia province, modulation of the wind power input into the grid takes place very often. On this line, which is connected to 380 kV Foggia and Andria stations, there are nearly 640 MW of wind production and 120 MW of photovoltaic production installed. The critical situation on this line is further complicated by the high number of NPRS plants installed on distribution grids, sometimes leading to the cancellation of the load of PS or even the inversion of flows. Up until the 150 kV connection of Deliceto SE to Ascoli Satriano – Agip Deliceto power line, taking place on 22nd May 2011, the line in question was congested for about 3000 h/year, with a missing wind production of 60 GWh in 2011. Also in this case, Terna, alongside improvement interventions, aims at installing storage systems in the years 2013/2014.

---

[10] For further information about the interaction between wind farms and the Italian electrical grid in the last decade, please consult the volume "Rete e Vento: lo sviluppo della rete elettrica italiana per la connessione e l'intergrazione della fonte eolica" (Grid and Wind: the development of the Italian electrical grid to connect and integrate wind sources), by F. Zanellini, www.aper.it

According to Terna, the following 150 kV backbones in southern Italy are to be considered critical:

- Foggia – Carapelle – Stornara – Cerignola – Canosa – Andria: there are currently 120 MW installed, plus 80 MW of wind and photovoltaic production. Moreover, 190 MW of wind production and 80 MW of photovoltaics will be added in the short term. The critical situation on this line is further complicated by the high number of NPRS plants installed on low and medium voltage, which are not run by Terna, and which sometimes have led to the cancellation of the load of PS or even the inversion of flows. Aiming at reducing congestion risks on the 150 kV segment of the line and considering the need to modulate renewable power input into the grid and prevent missing production, Terna has arranged a series of development interventions, among which the installation of storage systems, which will start working in 2013/2014.
- Galatina SE – Martignano – San Cosimo – Maglie – Diso – Tricase – Galatina SE: the Salento area is characterized by a high number of renewable sources plants, especially photovoltaics. On the backbone in question, there are currently installed 220 MW of photovoltaics (expecting to increase up to 160 MW in the short term) and 20 MW of wind production (Expecting to increase up to 250 MW in the short term). Also in this case, Terna, alongside improvement interventions, aims at installing storage systems in the years 2013/2014.
- Feroleto SE – S.Eufemia – Jacurso – Grifalco – Soverato (power installed from wind and photovoltaic production, of 312 and 6 MW respectively, NPRS potentially increasing by 20%).
- Rotello PS – Rotello SE (currently 12 and 13 MW of wind and photovoltaic production respectively, with a potential increase in NPRS installed capacity by 770%).
- Foggia – S.Severo – Serracapriola – San Martino in Pensilis – Portocannone – Larino: renewable plants are connected on this backbone, the power being of 160 MW. In view of further development of renewable sources both on the high and medium voltage grids, new interventions are needed on the high voltage grid. Consequently, there will be an increase in the risk of Energy Not Supplied (ENS) to end consumers connected to PS on the line and a reduction in the quality of the service provided. Because of the number of plants from renewables and the absence of considerable loads on this line, Terna believes that complementary interventions have to be carried out in order to enhance the transmission capacity, e.g. the installation of storage system along the critical backbone in question. The installation date is still to be defined.
- Villa S.Maria – Castel di Sangro – Campobasso (currently 124 and 7 MW of wind and photovoltaic production respectively, with a potential increase in NPRS installed capacity by 70%).
- Larino – Ripalimosani – Campobasso (currently 58 and 25 MW of wind and photovoltaic production respectively, with a potential increase in NPRS installed capacity by 160%).

- Bari Ovest – Rutigliano – Putignano – Fasano – Ostuni – San Vito – Brindisi Sud (currently 124 MW of photovoltaic production installed, with a potential increase in NPRS capacity by 280%).
- Taranto Nord – Grottaglie – Francavilla – Mesagne – Brindisi Sud (currently 50 MW of photovoltaic production installed, with an expected increase of NPRS plants by 120%).
- Francavilla – Campi Salentina – Lecce Industriale – Lecce (188 MW of photovoltaic production installed, with an expected increase of NPRS plants by 30%).
- Foggia – Trinitapoli – Barletta Nord – Barletta – Trani – Andria (24 MW of photovoltaic production installed, with an expected increase of NPRS plants by 360%).
- Foggia – S.Sever – Lesina – Termoli (131 and 44 MW of wind and photovoltaic production respectively, with a potential increase in NPRS installed capacity by 60%).
- PS Melfi – Venosa – Forenza Maschito – Genzamo – Tricarico – Gravina – Altamura – SE Matera (40 MW of photovoltaic production installed, with a potential increase of NPRS installed capacity by 250%).
- Taranto – Palagiano – Ginosa – Scanzano – Amendolara – Rossano (Ionian ridge): 20 and 111 MW of wind and photovoltaic production respectively, with an expected increase in NPRS installed capacity by 300%).
- Scandale – Crotone – Isola Capo Rizzuto – Cutro – Belcastro – Simeri – Catanzaro: the Calabrian Ionian side, the provinces of Crotone and Catanzaro in particular, hosts a high number of production plants from renewable sources, especially wind farms. On this line there are currently 280 and 10 MW of wind and photovoltaic production respectively, with further 110 and 20 MW (wind and photovoltaic respectively) to be installed. Terna plans on enhancing the grid and installing storage systems in the years 2013/2014.
- Scandale – Strongoli – Rossano: 138 and 16 MW of wind and photovoltaic production respectively, with an expected increase in NPRS installed capacity by 100%.
- Cetraro – Paola – Amantea – Lamezia – Feroleto: 10 MW of photovoltaic production and an increase of NPRS installed capacity by 1630%.

The 150 kV Sicilian backbones which are to be considered critical are:

- Tempio Pausania – Assoro – Valguarnera: 71 and 7 MW of wind and photovoltaic production respectively with an increase of NPRS installed capacity by 90%.
- San Cono – Mineo – Scordia – Francofonte – Francofonte PS – Carlentini – Augusta 2: 207 and 65 MW of wind and photovoltaic production respectively and an increase of NPRS installed capacity by 50%.

- Augusta – Sortino PS – Carlentini 2 – Vizzini – Vizzini PS – Caltagirone – Barrafranca – Caltanisetta: 119 and 34 MW of wind and photovoltaic production respectively with a potential increase of NPRS installed capacity by 80%.
- Caltanisetta – Petralia – Serra Marrocco – Troina – Bronte – Ucria – Furnari – Sorgente: the central part of Sicily is characterized by a high number of wind farms; on the backbone in question, there are currently 250 and 20 MW of wind and photovoltaic production respectively with an expected increase by 90 and 30 MW (wind and photovoltaic respectively) in the short term. Here too, Terna has planned, alongside traditional development activities, the installation of storage systems in the years 2013/2014.
- Favara – Racalmuto – Caltanissetta: 19 MW of photovoltaic production installed and an increase of NPRS capacity by 400%.
- Caltanissetta – Castronovo – Ciminna: 19 and 18 MW of wind and photovoltaic production respectively and an increase of NPRS capacity by 20% in the short term.

Enel Distribuzione has identified other sites where storage systems may be installed, as shown by the table below:

REGION	PRIMARY SUBSTATION	POWER (MW-MWh)	REGION	PRIMARY SUBSTATION	POWER (MW-MWh)
Abruzzo	S.OMERO	2MW-2MWh	Piedmont	SALUZZO	1MW-1MWh
Abruzzo	CARUNCHIO	1MW-1MWh	Piedmont	SPINETTA	2MW-2MWh
Abruzzo	ROSCIANO	1MW-1MWh	Piedmont	BIELLA SUD	1MW-1MWh
Basilicata	FERRANDINA	2MW-2MWh	Apulia	LIZZANO	2MW-2MWh
Basilicata	TRICARICO	2MW-2MWh	Apulia	CAMPI SALENTINA	2MW-2MWh
Calabria	ISOLA CAPO RIZZUTO	2MW-2MWh	Apulia	FRANCAVILLA	2MW-2MWh
Calabria	LAMEZIA T.	2MW-2MWh	Apulia	CASAMASSIMA	2MW-2MWh
Calabria	STRONGOLI	2MW-2MWh	Apulia	FOGGIA INDUSTRIALE	2MW-2MWh
Calabria	CHIARAVALLE	1MW-1MWh	Apulia	GALATINA	2MW-2MWh
Campania	MARZANELLO	2MW-2MWh	Apulia	S.VITO DEI NORMANNI	2MW-2MWh
Campania	MONTEFALCONE	2MW-2MWh	Apulia	CARPIGNANO	2MW-2MWh
Emilia Romagna	CONSELICE	1MW-1MWh	Apulia	BRINDISI CITTÀ	2MW-1MWh
Lazio	CAMPOSCALA	2MW-2MWh	Apulia	TRINITAPOLI	1MW-1MWh
Lazio	TARQUINIA	2MW-1MWh	Apulia	TARANTO EST	1MW-1MWh

Lazio	CANINO	2MW-2MWh	Sardinia	ISILI	2MW-2MWh
Marche	FORCE	2MW-1MWh	Sardinia	NARBOLIA	2MW-2MWh
Marche	COLMARINO	1MW-1MWh	Sicily	VALGUARNERA	1MW-1MWh
Marche	S.LORENZO	2MW-2MWh	Sicily	LENTINI	1MW-1MWh
Marche	TREIA	2MW-2MWh	Sicily	RAVANUSA	1MW-1MWh
Molise	PORTOCANNONE	2MW-2MWh	Sicily	FRANCOFONTE	1MW-1MWh
Molise	MONTECILFONE	2MW-2MWh	Sicily	CALTAVUTURO	2MW-2MWh
Molise	MORRONE	1MW-1MWh	Tuscany	MONTEROTONDO	1MW-1MWh
Molise	RIPALIMOSANI	2MW-2MWh	Veneto	SALARA	1MW-1MWh