STRATEGIC CONTRIBUTION OF

ENERGY STORAGE

TO ENERGY SECURITY AND INTERNAL ENERGY MARKET

HIGH LEVEL ROUNDTABLE

19 May 2015

Minutes

The Roundtable was opened by Tudor Constantinescu, principal adviser in DG Energy of the European Commission. He welcomed participants on behalf of Mr. Ristori underlining the importance of all stakeholders to participate in forming a comprehensive approach to energy storage over the whole energy system. Energy storage is expected to contribute in the integration of renewables and to improve energy security, supporting at least two of the main pillars in Energy Policy.

Paul Rubig highlighted the cost of the use of fossil fuels and also their impact to environment. The cost of photovoltaic and wind power generation is reducing rapidly, which should be seen as an opportunity for Europe, as that could create new jobs and industries in Europe. Storage is a key issue in the integration of renewable energy and the safe functioning of the energy system.

The **characteristics and state-of-art of various energy storage technologies** was presented by **Luís Costa.** In addition to the power-to-power storage, storage and flexibility could be provided by links to other energy vectors. Thermal storage systems are linking the power sector to the heat and cold markets, while hydrogen storage makes the link between electricity vector and many other vectors, providing new solutions in the energy system as a new energy carrier. The linking of the different sectors requires that the definitions of efficiency are clarified, including the points of measurement and the form of energy input and output.

The markets do not recognise all the value provided by storage, slowing the deployment of optimal flexibility solutions. Optimal investment and grid service solutions could be identified by system analysis, which would take into account the specific needs and characteristics at that point of the energy system and would result in an optimal mix of technology solutions. For a given balancing service, a faster reaction time will reduce the need for that service, while installation of additional storage brings the generation and point of demand closer. This could create a virtual copperplate, as the power lines are not needed to provide the same service.

A. Westgeest (EUROBAT): All battery technologies should be considered for energy storage given their characteristics and high recycling rates.

Session 1: "Storage in the new energy system"

M. Sterner (Regensburg University): Moving from fossil fuels to renewables reduces the storage capacity in the electricity system. An electricity grid expansion to the theoretical "copper plate" level would be very expensive and would not solve the variability issue. Without this theoretical European copperplate, storage will be needed much earlier than many models indicate.

Gas storage capacities are an unique existing assets and can cover long-term storage needs and could now be used as a flexibility element in the energy system. Linking the power sector to other sectors will be crucial for achieving the decarbonisation objectives. Fuels for transport sector could be produced from wind and solar power, as that provides much higher yields per hectare than biofuels from biological sources. That would improve the yield of the fuel and also mitigate the land use change issues. The chemical industry is another important sector for the decarbonisation objectives, as it has the biggest decarbonisation potential together with the mobility sector.

The financing of the energy transition should take account of the strategic dimension. The creation of “strategic renewable reserves” could reduce import dependency. Current strategic energy reserves are in most cases not purely market financed, and therefore the mechanisms to transition to a "strategic renewables reserves" needs to be considered in the regulation as well as in the market design.

A. Carolina Tortora (Terna): addressed the value of electricity storage and flexibility. From technical point of view the lack of common standards is an issue which increases the risk for the investors. Standardization entities must receive feedback and support from System Operators as well as utilities. The investment risk could be reduced by creating standards and models or by risk-sharing with suppliers, who could sell a storage service and not just a storage system, guaranteeing that service for a given period.

Storage can behave as a load or as a generator, but it can also provide support to the safety of the grid. This multiple nature throughout the entire energy value chain makes ownership of these assets a political as well as an economical issue. The focus should not be on the ownership of the asset but on the service for which it is used.

Storage also needs a fair market access. Most ancillary markets today are capacity markets. They are defined by the amount of power that should be provided (indefinitely) to the grid. This is an unfair disadvantage for storage which is limited by its capacity. One solution could be to determine length of services based on credible events on the grid, taking advantage of all the different ancillary services and taking care not to overlap services, and allowing distributed generation to the markets. Also bilateral agreements could be used to provide cross-service reserves. Future RES developers could be required to install their own storage in order to neutralize some of the same issues they cause and bring RES closer to market.

D. Ristori (DG ENER): This is the right moment to examine what is the right place of storage in the European energy system, in the context of the Energy Union. In the past storage has been clearly under-evaluated and we have now the opportunity to reflect on the solutions for the new energy system. Energy storage should be in the top of the design of the new energy system.

The European internal market has changed significantly over the last years. Major challenges have changed over the last 5 years, with focus on generation variability and energy security. These aspects should be included in the discussions on the new electricity market design. The variability of renewables needs to be backed up by a capacity that can balance the grid. We need a better coordination of capacities. At the same time storage will become more important.

In the beginning of next year we will present new rules for the European internal markets. We will examine all capacities to facilitate identification of best solutions. In the context of energy security we look at both electricity and gas. A legislative proposal will be presented before the end of next the year.

P. Clerens (EASE): The current emergency restoration code proposition mentions storage, but only as a load. This means that storage facilities need to be disconnected as a part of the first emergency procedure. Storage should be allowed to contribute to the stabilisation of the grid.

D. Ristori: I agree on this but I also remind that communication is a crucial part of the preparation of good regulation.

A.Pototschnig (ACER): Storage is driven by the profits from price spread, adequacy of supply and short-term flexibility. Gas can provide these 3 functions and thereby provide a greater flexibility in the electricity system. Different uses of storage may call for different governance requirements and regulatory treatments, depending on the ability to create competition among storage operators (e.g. in the case of UGS) or with other resources providing similar services (e.g. from electricity generation or demand response)

The potential of new technologies should be recognised in the energy system. The business case for storage should take the value and revenues from all types of uses. Currently a definition of electricity storage does not exist in regulation. Various procurement and remuneration regimes for balancing and (other) ancillary services are used across Europe. There is a need for a greater harmonisation and transparency of ancillary services procurement across Europe. Rapid adoption and implementation of the Electricity Balancing Network Code would contribute to promote flexible technologies, including storage.

Panel 1: Storage in the new energy system

P. Clerens (EASE): Energy Storage should be recognised as an own asset class in all electricty related regulations due to its particular nature: can act both as a power source and as a load. Therefore, EASE proposes an Energy Storage definition for the electricity vector which aims to bridge the lack of this definition in all relevant legal texts:

An “Energy Storage Facility” for the electricity vector is a facility used for the intake and stocking of electricity in different suitable energy forms. The release of this energy, at a controlled time, can be in forms that include electricity, gas, thermal energy and other energy carriers.

All stakeholders are invited to comment on it.

F. Ermacora (ENER.B2): A legislative proposal will be prepared on the electricity market design. A consultative communication will be launched this summer, and storage will be a part of the flexibility measures in this context.

D. Salisbury (GERG): The storage discussion needs to focus on energy storage in totality, not limited to electricity storage. The grids need to be vertically integrated (gas, electricity, heat and CO2 networks). Cross planning of the networks will have to be reflected in the regulatory framework, enabling the benefits of the various grids and storage methodologies. The research should also look at both the electricity and the gas side of the power-to-gas technologies.

A. Aguado (EDSO): Most DSO's are not allowed to integrate storage into their grids not only due to its high cost, which do not facilitate the business case, but due to existing national regulatory frameworks that do not allow to do so. However, since already today 90% of the renewable power (RES) is connected to the DSO networks, storage solutions will be necessary at any cost with the foreseeable increase of RES shares in the future. This is necessary to guarantee the security and reliability of the networks. Specially for DSOs, grid-optimised storage can help address RES peak production and therefore congestions.

The question whether network operators will be able to own storage under strict regulation for near-to and emergency situations, but operated by the market in all normal circumstances, is an issue that needs further discussion.

O. Grabette (RTE):

The current storage assets could shut down over the next years because of lack of business cases. The short-term issues should be solved to maintain these storage facilities. One of the issues is the FIT for renewables, which reduces the price spread and weakens the business case for pumped hydro. The role of storage needs to be defined. Currently storage is sometimes treated as consumption, sometimes as generation and sometimes as both, which could mean double grid tariffs for storage. The services provided and the rationality of storage investments are different for different storage purposes and this needs to be taken into account when designing the framework for storage.

Session 2: "Energy storage markets"

J. Zahurancik (AES): A fast responding storage smoothens the required adaptation of conventional generation capacity, thereby providing a more optimal system. This reduces emissions as the conventional generation can operate in its best efficiency range. The services provided by storage both when charging and when uncharging needs to be reflected in grid code, while storage should not be seen simply as load or/and generation.

A clear regulatory framework is necessary to allow storage to compete for grid services. The regulation should define services rather than technologies providing the services. At the same time the visibility into system security and flexibility needs to be improved. Markets should be designed to favour solutions that lower emissions and enable the increasing use of renewables. The market framework should recognise the beneficial “controllable load” characteristics and recognise that the cost of storage could be offset by a higher cost reduction elsewhere in the system.

Net charging and transmission costs (grid fees) for grid resources makes business cases for storage difficult. Duration requirements tied to service need to be made cost effective, based on the cost reductions that they provide. Technically the qualification processes needs to be transparent and non-discriminatory. Finally. a “pay for performance” mechanism could provide shared incentive for improved services.

A. Westgeest (EUROBAT): Batteries can provide a broad range of services to the electricity grid but the business cases that could optimise electricity system operation are limited by legislative barriers, dis-incentives and insufficient service valorisation. The main issues are the lack of definition of energy storage, support for curtailment of renewables and value streams that are not valorised by the current markets.

A definition of energy storage should be included in the regulation and storage should not be labelled as "regulated generating asset". TSOs/DSOs/independent actors should be allowed to have regulated access to storage. The restructuring would need to focus on removal of legislative barriers to storage.

Clear and binding national roadmaps are fundamental to take advantage of available tools and resources to ensure a decarbonized, secure and stable energy market. A capacity market should be introduced in a well-coordinated way.

The value streams for storage would need to be materialised by removing dis-incentives for distributed energy storage and design the market to valorise storage for its services. In this context the grid fees for electricity storage should be removed, as storage provides the necessary services to the grid. Also net-metering schemes could bring investments that provide flexibility and storage to the grid. Market structure must reward value, like response time. Base load power could have RES as the first priority.

K.P. Röttgen, (E.On) presented interlinks between the various energy systems; power, gas and heat. The power–to-power solutions were illustrated with battery storage, which has a wide range of application areas from individual households to transport. The cost of batteries has dropped significantly over the past years.

Power-to-gas technologies can link the electricity grid and the gas grid. Hydrogen generated through electrolysis can be used in many solutions in and outside the electricity system, and it provides especially interesting link to industry and transport. Hydrogen can be used in industrial processes, like in refineries, in transport, in power and heat generation and it can be stored in large quantities. Combining the hydrogen with CO2 to produce synthetic methane provides renewable methane which is interchangeable with natural gas in all applications, including CNG cars. In refineries the use of hydrogen could be used to increase the renewable share in fuels, like the E5/E10 gasoline. Decarbonisation of the non-electricity sectors could provide for business cases that supports the sustainable decarbonisation objectives.

Power-to-heat can participate to the balancing of the grid, for example through the German secondary negative balancing power market (via E.On EPP). In an CHP plant it allows participation in imbalance market and contributes to optimized use of gas and power.

With a large share of renewables in the grid, the cost of the energy system is lower with storage than without storage. Storage does not have sufficient market access and its value to the energy system does not have a tradable market value. Therefore it is not sufficiently considered in system planning. Further burden is put by fees and taxes, which does not take into account the functionality nor the value of storage.

Panel 2: "Energy storage markets"

H. Ten Berge (Eurelectric): Storage will be used by markets parties and by regulated parties like DSO's and TSO's. Storage capacity could be provided as a service which can be traded on the market and procured by regulated parties, like TSO's and DSO's. Regulated parties can obtain the service from the market but should not be a service supplier is such a market. The basic rule should be "Everybody should balance", including the renewable producers. The new guidelines from DG COMP are going in this direction. Today 35 operators are providing balancing services in Germany.

Demand response, interconnectors and adaptation of generation could provide similar services as storage. Household-level loads response should be remunerated for the same service as other for the same services. This will be a competitive market.

Storage should not be subsidised. That would distort the markets and will in long term harm the optimal deployment of storage. DSO's should be able to procure these flexibility services, just like everyone else and double grid fees needs to be abolished.

S. Mori (ENEL): New investments should be promoted by a sound institutional framework. Conventional storage technologies, like pumped hydro, are market oriented. At the same time, in order to be profitable, they need a specific utilization pattern. Today this business case is melting away, partially because of the increasing amount of renewables.

On the other hand, the increase in production from intermittent renewable energy sources enhances the importance of storage capacity for grid use. Grid stability problems due to high production from intermittent renewable sources would not probably be solved by markets alone. In addition, in small isolated islands storage solutions could buffer seasonal variations. Currently it is very difficult to define how the market should look like for this application, but no doubt a European approach for distributed generation and distributed self-generation is needed.

In addition, new investments should also take into account the potential of electro-mobility, which could provide storage services to the electricity grid. Currently there are no mechanisms to compare the benefits of different flexibility solutions. It is very difficult to make a merit order of the possible solutions. A European market for balancing could clarify the role and the solutions..

G. Hotellier (Siemens): It would be important to have a clear non-political cost comparison of the different options. In the German example, currently the peak generation periods the energy is exported. This prevents the deployment of new solutions and avoids the discussion about the

optimal solutions for the energy system. A non-partial cost-benefit analysis is needed to implement the full transparency.

H-M Henning (Fraunhofer): The well-known "Duck-curve" in US is partially caused by air-conditioning. That is an example of where demand could be shifted by shifting demand by generating ice during low-demand period of the day. This underlines the need for the intersectoral integration. Heat and cold storage are the cheapest storage forms, while mobility could come in a medium term. To create a stable future system, we need price spreads, also in households, in both directions.

E. Scotto (AkuoEnergy): In some French islands all new renewable capacity needs to be balanced, by law. We have installed batteries that are now balancing the generation. It is necessary to work together with TSO, so that the production can be adapted according to the information about demand. Balancing is now done at the substation level, not on PV plant level. Adding 20 MW of storage (response time 500ms) the 400MW generation can reduce curtailment with 50% and increase the penetration from 30% to 40%.

Q&A:

Q: P. Clerens: How should energy storage market be regulated? Does national regulation make sense?

A. Westgeest: Currently the national regulation is fractioned while EU level approach is lacking. The fractioned approach with different regulations in different MS's does not seem to be a future solution.

H. Ten Berge: Is "Market" regulated or not regulated? Market should not be regulated, but regulation could provide a framework for the market. That would be transparent to generation, interconnectors, etc. The potential framework should be on European level.

Mori: We have large diversity of regulations on national and regional level and this must be addressed as a burden. A EU level framework should urgently fill the gaps and ensure that the market hurdles are removed.

Hotellier: We need to have all 28 Member States as a single market, as only that can provide the volume that is needed for innovation, and which also is needed to be globally competitive.

J. Zahurancik: There is a role in eliminating the barriers and replicate what works over other states, so that we can build momentum in this area.

Wilhelm (Geopolis): Question for Westgeest: Materials research is crucial. We need R&D in Europe to be competitive. Where do we stand in relation to the rest of the global competitors?

Answer: Westgeest: We are in the middle, we are ahead in some areas and lagging in others. The manufacturing in Europe could still be increased. This is a large opportunity, which could be supported by the Energy Union.

M.Steen: Concerning the European level regulatory framework: We have agreed on high level policy goals (renewables, Security of Supply, etc.). We also need to think about climate change effects

which are likely to negatively affect security of energy (and transport) infrastructure. Energy policy will need to consider climate change adaptation, and this requires EU level action.

Financing:

C. Germann (Illwerke AG): Financing is looking into low risk and stable revenue streams, avoiding risks in currencies, etc. The current projects on pumped hydro storage plants are driven by the rapid expansion of renewables in Germany increasing the fluctuating share of power generation. At the same time the overcapacities from thermal power stations is reducing and the low CO2 price could provide potential.

The identified opportunities for storage investments are related to the integration of renewables, increasing demand for flexible generation capacity and market recovery after shut down of overcapacities. Biggest risks in investments relates to political and regulatory uncertainties, complexity of approval procedures, changes in long-term investment framework and changing competition over the investment period.

As conclusion concerning investment in pumped hydro storage plants, it is clear that the future electricity system will consist of both centralised and decentralized components. Looking at the centralised components, we are convinced that pumped storage will keep its importance due to high efficiency at acceptable costs. The crucial aspect of these centralised solutions is a stable environment for investments.

Discussion panel: "Financing and Further Actions"

A. Díaz Vázquez (Abengoa): Financing is a very challenging part of the deployment. It's easier to finance CSP with storage than without storage. Storage decreases the LCOE as the power can be sold over larger time bracket. Also financing R&D is important for developing further new solutions. The framework in todays' context needs to be addressed from the point of view of the whole system, not individual solutions.

K. Staschus (ENTSO-E): We need strong grids to integrate renewables and to keep the system secure. The key aspect to manage the investments is the market design. Integrating the EU wide markets is important and needs still attention. The renewables should be functioning mainly on market basis. The diversity in European markets is still too high and that prevents a good functioning of the internal markets and introduction of financial instruments that could be used to control the investment risk.

As part of the Ten Year Network Development Plans we are doing cost-benefit analysis on infrastructure projects and storage projects. Storage has to prove itself on the market; it's not directly linked to ownership. Our members experienced that the needs for storage is not provided by the markets and therefore they have to invest themselves, bringing up the questions about market viability, also the impact of regulators and regulations.

T. Brabo (Energinet.dk): In Denmark the infrastructure for gas, power and storage is in one company and a long-term political consensus has provided political stability. A more unified European

approach to storage would be beneficial. Energy storage is an element in the new energy system, not only electricity system.

Cooperation of all actors (industries, TSO, DSO, etc.) is needed to be able to consider the whole energy system in the planning. Some of the solutions in Denmark are not directly applicable to other countries but the existing similarities and solutions could be considered for a sustainable long-term energy system planning.

O. Teller (HEA): European industry is strong, with 50% of the global markets. The biggest hurdle in investing in Pumped hydro is not the site nor environment, but the long-term business case. An investment of 40 years is now considered very risky.

Grid operators are happy for services by pumped hydro, because of the fast reaction time. But there is not always remuneration for those services. In some markets contracts for 20 years are signed for services, while in Europe that kind of contracting is not available.

From system point of view an increased quantity of storage could be beneficial, cheaper than relying on other solutions, but individual actors don't see their interest in investing in this technology. It is important to have a level playing field to all flexibility solutions.

T. Deschuyteneer (GIE): The large gas storages were justified to balance the stable production and seasonal consumption patterns. The existing gas infrastructure could now and in future be used to provide for also flexibility to the electricity grid. Electrification of heating is expected to increase, with larger use of heat pumps. Those are used seasonally and therefore the load factor of the electricity system is going to decrease. Gas and electricity will be complimenting each other in the future.

Seasonal characteristics of storage could be used as flexibility element in the electricity grid. Gas storage is fully integrated into the gas infrastructure and gas markets are liquid. The profitability for these long-term gas storages has decreased, as the summer/winter spread has reduced, and is now below the long-term marginal cost for new investments.

Strategic reserves could need regulation as security is a public good, but market mechanisms could also be developed to provide this type of storage. In future the security of supply needs to be valued by the markets. Some countries have imposed supply obligations, so that consumers will install storage and secure the adequacy for peak demand. These types of action can ensure that markets are delivering the system adequacy.

Q&A

Question: M. Salomon: We are moving to shorter products and smaller minimum products. However, the new countries have the same issue still: how do you invest when you have only hourly/daily pricing? How could the long-term balancing be justified in these markets?

Question: M. Wilhelm: (to Stacschus) How far in detail do you look into risk scenarios in the transmission planning from grid operator point of view, especially concerning he assumptions concerning cost reductions in battery technologies and increasing the their energy density? How sensitive is the need for transmission infrastructure extension to those kind of assumptions?

Question: **Sterner**: (to Ristori) We set up the strategic reserves as a response to the energy crisis 70's and 80's. 80% of stored energy is fossil energy. Could we have a storage transition to renewable storage? Could a strategic green storage be introduced and should chemical storage be a part of this strategic storage?

Question: **L. Lo Schiavo**: We made a cost-benefit analysis of how the different services could be combined. We have therefore interest in the ENTSO-E analysis. Distribution companies should be allowed to use storage for their own needs. CEER raised in their last consultation in the topic. This should be seen in the context of integrating distributed generation.

Answer: T. Brabo: The market directives 1998 and 2003 were market oriented and back then we were too eager to support market approach, the short-term market, and maybe neglected the aspects of stable investment framework for some technologies. We are now opening up the market for longer-term markets, up to 10 years. This shift is seen on several countries in support to the investment climate.

Answer: T. Deschuyteneer: Storage operators are making marginal investments, optimising their current investments and existing infrastructure. The main insecurity and question is the future use of gas. Therefore a stable and clear future market design of very important.

O. Teller: Pumped storage can participate in primary and secondary at the same time as doing energy arbitrage. This simultaneous participation in different markets requires large power that is indeed commonly available in pumped hydro.

C. Germann: We advocate a market design where demand response and storage of all sizes can operate. The business cases on both of these markets depend on the possibility to make revenues in all available markets, including the short-term reserve market. Our balancing network code, now in ACER for evaluation, foresees these solutions and pushes these to the European markets. We are learning through pilot projects and early implementation projects already. We have made several scenarios and those also imply a significant role for grid extension.

K. Staschus: Balancing code made a good progress on pushing the market approach further. The code is not yet effective but will hopefully be soon. Market requires a stable setting. The risk scenarios : The cost reductions of storage is very uncertain and our modelling includes several uncertainties. Therefore we open up to a broad spread of scenarios to mitigate the risk of modelling. That scenario includes also demand response from batteries and significantly stronger grid.

Donnelly: In conclusion the key message seems to be that storage should be seen as a part of the total energy system and should be used to optimise the system. We need to have an integrated approach to R&D, and not picking technologies.

Ristori: Thank you all for your input, which is very valuable. There is a strong interest in storage, which is the result of rapid market evolution, both in generation and storage. We have also the developments in the LNG markets and with shale gas. These aspects should be taken into account when planning the future energy system.

The rapid penetration of renewables, which is expected to continue, has shown the importance of managing the transition to the new energy system. A high level of coordination between all actors on the market is crucial.

On European level we support a rapid development of technologies. There's a lot of progress to be seen on batteries, on hydrogen and to ensure the link with renewables. EU services will work on integration of the RES and on the design of the markets, using all instruments that can help in achieving the policy objectives.