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Hearing

Contribution of coal and lignite to the EU's energy security.

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1. To introduce the topic, there are several good reasons which convince us to still use and talk about coal. The first: according to estimations made by the World Energy Outlook 2014 the demand share of this form of fossil fuel, on a world level, should be reduced from 29% (2012) to 24% (2040). And while the demand from European Union countries could be reduced in the period 2012-2040 by 3% per year, that of non OCSE countries could grow on an average of 1% per year with points of almost 3% for India. The second observation is addressed at the United States, who – in particular in recent weeks – have demonstrated that they are still the economic driving force in the world. There are still more than 500 power plants run on coal, with a production of 1500 GWh, which equals approximately 40 % of the electric energy produced. President Obama has called for an intervention to reduce this impact but this is the current state of the situation.

2. Coal is undoubtedly the primary source of energy which corresponds to the strategic objectives of security and economic sustainability of the supplies, as defined in the energy policy of the EU and other fundamental regions of the world (1). However, the long term future of coal is influenced by the availability of technology which comes as close as possible to "zero emissions", which have been tested and are applicable on an industrial scale, as well as being economically sustainable. The coal will have to be compared to natural gas, or rather the primary fossil fuel which is considered preferable for the transition towards 2050, as it achieves environmental objectives more easily (2) with a favourable trend in price and ascertained reserves. Besides the competition with natural gas, it is necessary to point out that the reduction in costs of production of supplies of renewable energy is occurring faster now than predicted in the past (3). To accomplish the objective of near to "zero-emission" coal use, it is necessary to take note of important progress that has been made in the increase of efficiency in the process of production of thermal and electric energy, in the efficiency of the industrial processes which use coal (heavy industry) and in the development in the process of capturing and storing carbon dioxide. Experts consider Clean Coal and CCS technologies as a relevant part of the combination of the options for containing the warming of the Earth generated by the growing concentrations of CO2. Available literature states that these kinds of technologies must be available and economically viable by 2030. Once they have become commercially competitive, all new investments in the production of electric energy from fossil supplies and in heavy industry will have to include the implementation. Therefore, the next years will be characterised by a greater effort for innovation and the transfer of innovation. It is also necessary to consider the fact that in the recent past, many demonstrative industrial projects have been cancelled as they resulted to be economically unsustainable. It is necessary to create general conditions so that investments in large scale plants can be effectively accomplished (4).
3. The European Union and the most industrialised countries are developing Clean Coal and CCS technologies with the aim of developing an internal industrial policy and also cooperation agreements, to facilitate the circulation of it in other areas of the world where the use of coal

is wide-spread and where there is a strong economic growth where negative environmental impacts are ignored. These objectives are contained in the Climate Change Framework for 2030, approved by the EU council and in the joint Declarations of the energy Ministers of the G7 (5).

4. The portfolio of the technologies include numerous options to make the production processes of electric energy and certain industrial processes more efficient.

4.1 A lot of progress has been made, for example, thanks to the developments in material sciences which have allowed a higher efficiency transformation productions by generating ultra super critical (USC) generators. The future objective is to achieve with the advanced ultra super critical (AUSC), an efficiency equal to or superior to 50%, by using alloys of nichel and chromium to manufacture components that can resist to temperatures of over 700°C (6).

4.2 Other technologies promise radical innovations. Among these are oxy-combustion of coal, obtained by mixing almost pure oxygen with recirculated combustion gas. By doing this, the fumes of combustion are mainly made up of CO_2 and water vapour, which is easily separated through condensation of the vapour itself. Among the oxy-combustion technologies, there appears a particularly innovative and potentially relevant way of applying it on a wide industrial scale, the technology called "pressurized isotherm oxy-coal flameless combustion", which is property of an Italian industrial group (7). The competitive advantages of this technology appear to be many: a) the possibility to fuel the plant with low quality coal; b) emissions are virtually none and the production of pure and concentrated CO_2 which is ready to be stored or to be used industrially; c)the versatility of the industrial application over a wide interval which varies from a few MWt to hundreds of MWt; d) a configuration of power plants based on elements with which the operators are familiar. This technology was experimented in a plant with a power of 5MWt and has been applied in a plant of 15 MWt fueled by urban waste. It is important to note that a research on the feasibility carried out by the Massachusetts Institute of Technology (MIT) (8) for a power plant (gross 454 Mwe, net 328 Mwe) based on this technology and with CCS, evaluates a higher cost of Kwh equal to 46% in respect to that of the KWh produced in a conventional super critical station. This value is close to the target of 35% of the higher cost of Kwh produced with CCS indicated by US-DOE and is less than the energy cost in relation to the technologies of post combustion in reference applied to a super critical plant (about 80%). The cost of the tonne of CO_2 avoided is also substantially lower. With this prerequisites the Sotacarbo Spa has signed an agreement to test a 50 MWt plant in the Sulcis area with a significant economic commitment by the Sardinia Region and the Government. As a result, this experiment could provide the technology to apply to a large-scale plant in Italy, as illustrated in the following point 8.

4.3 As regards the gasification of coal, it is useful to recall that although the large-scale industrial applications still only regard a limited number of cases, gasification with de-carbonisation, is one of the technologies which has the most possibility to be used with clean coal. From the environmental point of view, the IGCC plants with the capture of CO_2, have an important advantage. The removal of pollutants occurs primarily on the *syngas* before combustion. The volume of gas to purify is vastly reduced and there are also more favourable chemical conditions. In these plants, the capture of CO_2 is much easier and less expensive than conventional plants with capture of CO_2 down the line of combustion.

4.4 The technology of gasification is also the natural candidate for the economy of hydrogen. The way of hydrogen from coal is accessible and appears to be economically interesting.(9) The application of the gasification technology has marked a passage for reasons of the higher costs of investment, the difficulties of running a plant that is more complicated in respect to conventional ones, the lower net economic efficiency following the energy used to produce the oxygen needed for the process. Various announced projects have been cancelled. The experience in the Sardinian Region is no different: in 1998 an IGCC power plant obtains the environmental authorisation from Ministero dell'Ambiente. The financing based on a scheme of *project financing* assisted by public incentives did not find an opening on the market. A later programme (2003) was evaluated negatively by the EU Commission as interference in violation of the laws on the aid by states. However progress has been made and at the moment these technologies show efficiency in IGCC plants of 46% (based on lower heating value) which is comparable with similar ones in ultra super-critical plants. The tendential target for 2030 is a gross efficiency of 51% (9). Recently in the USA a 582 MWe plant has been put in use. It is the first of its kind to use gasification and CCS, with a capture target equal to 65% of CO_2 produced which will be used in applications in Enhanced Oil Recovery (EOR) (10). The gasification technology with the capture and storage of CO_2 has been put forward as a candidate for a plant in Italy as in point 8.

The National Energetic Strategy (11) drawn up in Italy in cohesion with the European strategy, highlights the importance of the CCS technology defining it as a priority in research. Various programmes have been proposed and developed (12). In this contest an important national Centre of Research is represented by Sotacarbo SpA, in Carbonia, equally shared by the Autonomous Region of Sardinia and Enea.

5. A ten-year programme has been financed for the development of Clean Coal Technologies and CCS. This programme is currently in progress (13). Sotacarbo is equipped with laboratories and structures for experiments including a pilot gasification plant equipped with a production line of hydrogen and one for the separation of CO_2.. The pilot structure has a capacity of 35 Kg/hr of coal. A demonstrative gasification structure has a capacity of 700 Kg/hr of coal. A pilot structure, based on the absorption in amines, is used for the tests of capturing and for experimenting the performance of the different types of absorption and solvents and regeneration.

6. Storage. Numerous studies of general research, research projects and industrial applications have been carried out or are under evaluation in Italy. Initial assessments estimate that the basins identified can store the entire amount of CO_2 produced in Italy in the next 50 years (14).

6.1 Among the industrial projects is the ZEPT (Zero Emission Porto Tolle) by Enel. The captured CO_2 should have been positioned via pipeline, in a saline aquifer reservoir situated in the Adriatic sea at 25 Km east of the Italian coast; it was cancelled due to economic reasons and national energy policies. In the mining area of Tuscany, the Fiume Bruna Coalbed Methane project is being carried out. The studies and tests on site have brought about the reclassification of the deposits which are now evaluated as *shale gas* instead of CBM (15).

6.2 The Sulcis area represents a unique situation in Italy. This region is characterised by the presence of deep layers of coal which is unminable (about 1 Gt) and by a saline aquifer below the layers of coal. The possibility of storage is considered to be the most important in Italy. Preliminary data from a study of feasibility indicate that the saline aquifer reservoir would be suitable as a site for geological storage of CO2. Other preliminary data (16) show that the techniques ECBM are potentially applicable for the deep layers of the coal basin with injections of CO2 and the recovery of methane gas. At the moment a research programme is being carried out based on two lines of work: a) the completion of the characterisation of the site and the carrying out of the tests on the injections; b) the implementation of a research structure including an underground laboratory for the injection of CO2 into the rocks and a laboratory on the faults of a shaft with a shallow well to directly inject the CO2 into the selected fault. The programme has a three-year development. It is financed and is expected to be concluded in 2017. The studies include Sotacarbo, Enea, Carbosulcis, the national Institute of geophysics and volcanology, and universities

7. The industrial demonstrative structure. A law by the Italian Republic (17) promotes the creation of a power station of the generation of electric energy with the capture and carbon dioxide to be geologically confined. The law foresees that the major cost of the capturing and storage of the carbon dioxide relating to the production up until 2100 Gwh/year, will be compensated by an incentive of 30 Euros/Mwh. The overseer of the network has the obligation to buy the entire quantity of energy produced. The first thing for the Sardinian Region to is to declare the international tender for the project by 30 June 2016. The law does not specify which technology will be applicable. Therefore all technologies are proposable. It is an opportunity at a EU level, to experiment a complete structure on an industrial scale. The project must be preliminarily presented to the EU Commission for validification in the respect of the rules for state aid. This programme emerges in the field of initiatives of the Italian government for Clean Coal Technologies and for the programmes for development in an area which is harshly hit by de-industrialisation and where the last active coal mine is in the phases of being closed down . It therefore also has a motive of social recompensation. It is however to be predicted that the project will come up against numerous obstacles, above all from a generally unfavourable climate for new plants fueled by coal, in any way they are projected. The first programmes of tests into the storage of carbon dioxide came up against opposite reaction from some groups of opinion.

8. Summary and conclusions

Coal is undoubtedly the primary source of energy which corresponds to the strategic objectives of security and economic sustainability of the supplies, as defined in the energy policy of the EU and other fundamental regions of the world. However, the long term future of coal is influenced by the availability of technology which comes as close as possible to "zero emissions", which have been tested and are applicable on an industrial scale, as well as being economically sustainable. A relevant progress occurred in the past years about such technologies but it needs more to do both in research and demonstration. It is worrying the lack of large scale demonstration plants and business cases in Europe. It is necessary to create better conditions for Plants first-of-the-kind as they need heavy investments.

Note.

(1)the previsions for the view for 2035 indicate that fossil energy supplies will satisfy over 75% of the demand despite the strong growth in renewable sources. The role of petrol decreases, and the share of gas rises, coal has overtaken petrol but there has been a perceivable drop in the OCSE zone and a sharp rise above all in the Asian area. In the production of electric energy there is anticipation for the shifting from coal to gas in te EU area and the USA. It is estimated that on a global level the established capacity for the production of electric energy from gas will overtake that fueled by coal in about 2030. For this see IEA World Economic Outlook 2012 and onwards and the European Commission, SWD (2013) 157 final, Technology Assessment. In the Italian case, gas has already overtaken coal in the production of electric energy. See the National Energy Strategy document. The report by Stephen Mills, Prospects for Coal and Clean Coal Technologies, IEA-CCC, June 2015, this states that this happened despite the fact that the cost of electricity is: 2,18 E/KWh. Oil fuel 5,51 E/KWh, gas 6,34E/KWh. As for the USA, see M. Galeotti, A. Lanza, Obama and pollution: good but let's not exaggerate, in lavoce.info, 26.08.15.

(2) the content of carbon per thermal unit is 55 Kg of CO2 per GJt in the case of methane gas against 92 Kg of CO2 per GJt for coal. Therefore it is necessary to take into account the data which comes from the entire cycle including that which goes from the extraction to the final use (Life Cycle Assessment, LCA). A lot of writing indicates that this is the most correct representation of the reality.

(3) for the development of the costs of investments per KW installed, and for technologies suitable for de-carbonisation, see the EC report, SWD (2013) 157 final Technology Assessment.

(4) in relation to this the EC report, SWD (2013) 157 final, Technology Assessment shows how the European Union in recent years is very behind in the development of these technologies, in respect to other areas of the industrialised world, in the realisation of investment for demonstrative structures on an industrial scale. The *Carbon Capture and Sequestration Database site* published a list of 11 European projects for structures to generate electric energy from coal, with the use of CCS technology, which had been announced and then cancelled. These are projects of the size of between 250 MW and 1600 MW, with technologies for capture using post combustion, with storage of CO2 captured, in saline aquifers or in exhausted shafts or to be used in EOR structures. The companies who proposed the projects are among the major European electric companies, and come from various countries. Sometimes projects that have benefit from the instrument NER 300 have been cancelled, as in the Italian case of the ZEPT, Zero Emission Porto Tolle. The cancellations are due to reasons which do not concern the technical availability but rather that of economic conditions for building and running the structures, such as the low ETS prices, the size of the incentives or the financial market. It is obvious that additional financial measures are necessary.

(5) in relation to this, European Council (23 and 24 october 2014) Conclusions on 2030 Climate and Energy Framework and G7 Energy, joint Declaration of energy Ministers of the G7, Rome 6 May 2014.

(6) among the numerous reports, see K.Nicol, Status of advanced ultra supercritical pulvirezed coal technologies. IEA, December 2013.

(7) for a synthetic description of this technology see Stephen Mills, Prospects for Coal and Clean Coal Technologies in Italy , IEA-CC, June 2015, pag 86-89.

(8) N.Seifkan, H.Zebian, R.Field, A.Mittsos, Pressurized Isotherm Oxy-Coal Combustion, MIT 2013.

(9) for an appraisal of the production of hydrogen beginning from the gasification of coal, see the review by G.Lozza, P.Chiesa, Capture and collection of CO_2 in fossil combustion structures, Politecnico Milano, in Energia 3/2007. See also the EC report, SWD (2013) 157 final Technology Assessment.

(10) see https://sequestration.mit.edu/tools/projects/kmper.html

(11) National Energetic Strategy: for a more competitive and sustainable energy, Italy, Ministry for Economic Development March 2013

(12)G. Girardi, SET Plan, Short Summary of Italian Contribution to the European Iniziative for Capture, Transport and Storage of CO_2, in Energia, Ambiente, Innovazione 1-2 2011. C.La Marca, A. Mangiaracina, M.Politi, G.Santo, C.Tabasso, M.Toschi, Enel Postcombustion CCS Project: from Laboratory Research to Demostration, EAI, 1-2 2011.

(13) As an illustration of the work developed by Sotacarbo SpA, see C.Frau, F.Ferrara, A. Corsini, A. Pettinau, Characterization of several kinds of coal and biomass for pyrolisis and gasification, International Freiberg Conference on IGCC, 2014.

(14) Stephen Mills, Prospects for Coal and Clean Coal Technologies in Italy, IEA-CC, June 2015.

(15) Stephen Mills, Prospects for Coal and Clean Coal Technologies in Italy, IEA-CC, June 2015

(16) A.Plaisant, R.Cara, D.Multineddu, preliminary studies on the application of ECBM technologies in the coal basin of the Sulcis. Report RSE/2009/151.

(17) See Law 21 February 2013, n.9, art.1,commi 11,12,13,14. It can be seen that even previously an Italian law authorised the realisation of power station equipped with CCS technology. On this programme, the EU Commission opened a proceeding for violation of the rules on competition acknowledging that the Italian government had allowed excessive incentives for the production of electric energy and indirectly also to the mine. Following this procedure of violation, it was decided to close the mine and to cancel the project . However, the Government and the Parliament decided, with the afore mentioned law, to promote a new programme for a demonstrative industrial structure with de-carbonisation, limiting the incentives just to the innovative components.