Shaping the energy future – new technologies in the context of climate change

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The great task of the 21st century is to limit global climate change. To avoid major catastrophic events, greenhouse gas emissions have to be reduced throughout all areas in a significant manner. This is especially challenging within the energy sector as huge amounts of CO_2 are emitted into the atmosphere by converting fossil fuels to energy. In the current discussion, there are several approaches to change the energy framework and to shape a new energy system. In the presentation, besides the description of the overall challenge and the general possibilities to limit climate change, with Carbon Capture and Storage (CCS) and geothermal energy two promising technologies are discussed.

CCS that means that CO_2 emissions from fossil-fuelled power plants, industrial sources or biomass production will be captured, transported and stored in the geological underground is technically available but still at very high costs and so far only in smaller scale than necessary for the application in huge power plants. Various rather smaller demonstration plants are working throughout the world and the upgrade to bigger facilities is under way and among others supported by the European Union. In the EU six power plant projects have been selected in 2009 to receive a substantial EU-funding as a major step for further development and the future market introduction of CCS. From today’s perspective, it is supposed that the technology will be commercially available between 2025 and 2030. The capture process is applicable (though with high efficiency losses) and the transport of CO_2 through pipelines has been shown in the US in particular for enhanced oil recovery projects. Most important and insecure in the CCS chain is the deposition of CO_2 and the available underground reservoir space which guarantees a safe and long-term stable storage.

The market introduction of CCS will depend on several aspects. Besides the demand for suitable storage capacities there are many more factors like ecological and economic impacts, the question of system compatibility and last but not least the public perception of CCS determining if and to what extent CCS will be part of the energy system of the future. Furthermore, recent studies show that the storage space for CO_2 is not only limited from a geological point of view, but it has to be divided between or shared by different forms of usage.

CCS can be used for power-plant emissions as well as combined with CO_2 from industrial point sources or biomass production. As industrial process emissions are less easy to substitute by renewable energies than fossil energy production, these emissions should be primarily sequestered. Another advantage is that many industrial applications provide a more concentrated stream of CO_2 after the capture process, so that the following steps can be achieved more efficiently. The other prospective form of CCS with biomass could lead to net-negative emissions which could be needed from 2070 onwards following recently published mitigation scenarios.

It is widely understood that the energy world of the longer term future have to be completely supplied by renewable energies. Wind is supposed to have the highest share (in particular in Europe) but geothermal energy can be also contribute substantially. Today, the energy system is static and provide huge full load from big plants. The shift towards a system with high penetration of renewable energies will decrease the demand for base load power plants. It will lead to significantly less full load hours for the conventional power plans than today making the life especially for fix cost intensive power plants much more difficult. However, the fluctuating energy provision has to be supplemented with efficient plants, providing high power dynamics. This shift in energy supply should be accompanied by a change on the demand side with smart energy solutions and more flexible consumers. The changing deliverable energy for households should be used most efficiently, e.g. by driving energy-intensive actions when energy supply peaks supported by variable prices. The most promising approach would be an intelligent energy supply system accompanied by a smart-grid where many different renewable energy sources are combined in one system, levelling out some of the fluctuations in the grid and combined with smart energy usage. Nevertheless integrating renewable energies with base load characteristic as geothermal energy would be more than helpful to cover all future challenges and to support the stability of the resulting system.

Both CCS and petrothermal projects, which are the most potential form of geothermal energy production, are dependent of available geological formations. There could be a potential conflict of usage although the needed depth is supposed to be slightly deeper (3,000 to 6,000 m) than for CO_2 injections (1,000 to 2,500 m). The underground space may also be used by natural gas storage to control demand peaks in winter time. Further underground applications are compressed-air- or hydrogen-storage which might be used in the future to compensate fluctuation due to the increasing share of renewable energies.

It is a question of strategic planning, which form of usage is regarded as most effective and to what time. So the regulation has to consider the various forms of competition. Several systematic problems are still unsolved and should be taken into account by regulators. The shift in the energy system has still to come and CCS as well as geothermal energy may contribute to the necessarily needed decarbonised new energy framework. All techniques should be demonstrated and researched so that the most effective path can be selected and action be taken. It has to be ensured that the distribution of underground space considers future technology developments and does not favour one option. An early and unconditional commitment towards CCS should be avoided in order to prevent limitation of alternative underground use as geothermal energy projects for instance.