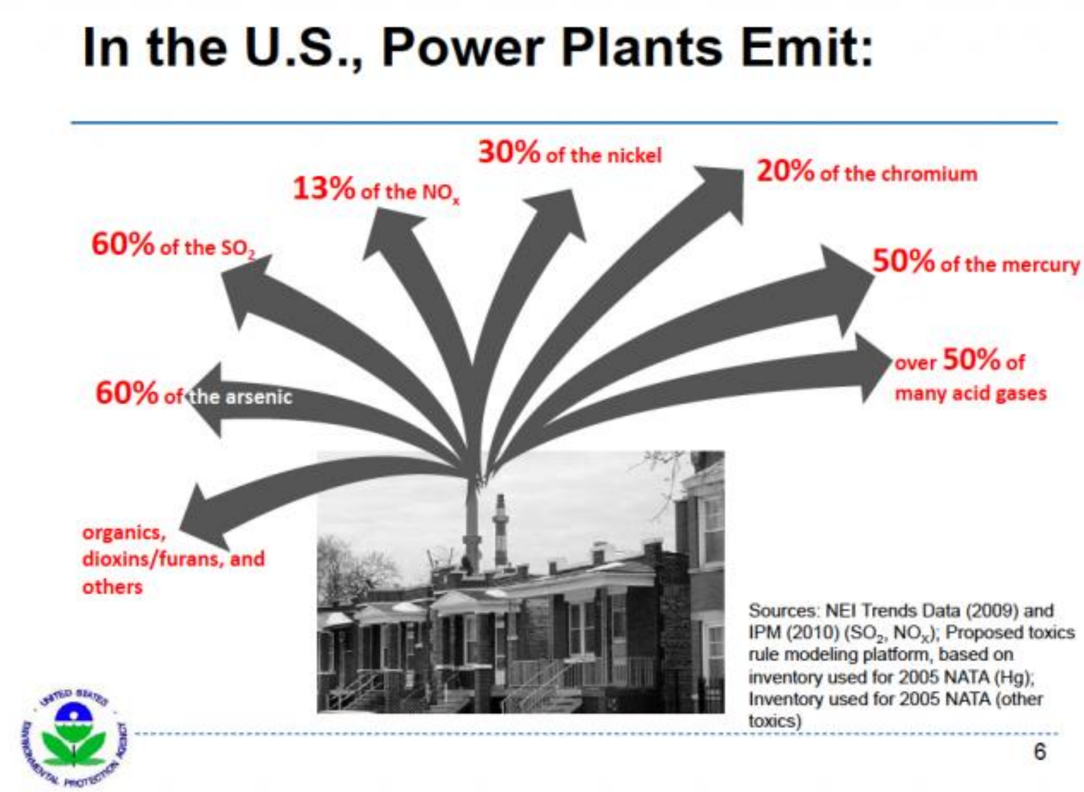
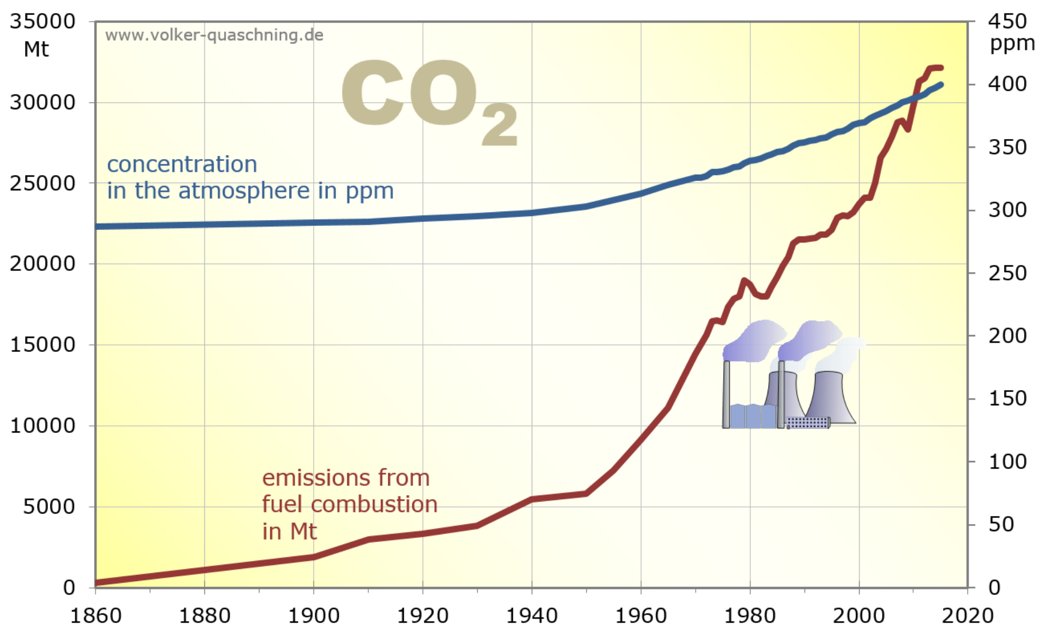
Project 1: Catalytic Elemental Mercury Oxidation

The U.S. EPA's new final rule, Mercury and Air Toxics Standards, requires coal- and oil-fired power plants to use maximum available control technology to strictly regulate the emissions of mercury and other hazardous air pollutants by more than 90% effective in 2016. Among elemental, oxidized, and particulate-bound mercury species present in flue gas, elemental mercury vapor is most difficult to control because of its low concentrations, low reactivity, and low solubility in water. Elemental mercury vapor has a long residence time in the atmosphere, and thus contributes to global-scale deposition. Dr. Lee's research group is studying detailed reaction mechanisms and kinetics responsible for the catalytic oxidation of elemental mercury vapor. He is also investigating the reaction and adsorption characteristics of elemental mercury vapor for a chemical adsorbent. A Protégé student will work with a PhD student on mechanistic and kinetic studies of elemental mercury over the catalysts.



Project 2: Energy-Efficient and Thermally Stable CO_2 Adsorbent for Post-Combustion CO_2 Capture

Post-combustion process in coal-fired power plants releases dilute carbon dioxide stream which is a major cause for increasing CO_2 concentration in the atmosphere. As an increase in human activities, the CO_2 concentration in atmosphere has reached 404 ppm in February 2016 that is reported to exceed a safe upper limit (350 ppm). This creates an expeditious need for suitable carbon capture and separation technology from existing coal-fired power plants. The flue gas from post combustion process consists of 10-16%(v) CO_2. Conventional post-combustion CO_2 capture processes using physical or chemical solvents require high regeneration energy of 3-4 MJ per kg of CO_2 captured, thereby increasing an operating cost of the absorption process. Dr. Lee's lab is studying CO_2 adsorption process requiring very low adsorption and desorption energy requirements.



Project 3: Targeted and Controlled Gene and Drug Delivery for Cancer Therapeutics

The development of nano-scaled carriers as a drug delivery platform has made a tremendous difference in the fight against cancer. Significant progresses have been made in improving linker stability, biocompatibility, and biodegradability of a delivery system, targeting, and drug potency. Among many challenges, metastasis and multi-drug resistance phenomena still remain major challenges that limit the technological development of effective nanotechnology-based drug delivery systems. To address these technical challenges, Dr. Lee's lab is developing a new class of smart gene and drug delivery systems with synergistic effect to target tumor and metastatic cancer cells. This novel nanoparticle-based delivery system has a few notable features of targeting to specific cells and sequential release of dual drugs for maximum efficacy. This new nanoparticle design can significantly reduce toxic side effects of conventional drugs used in chemotherapy by using ~100 times less amount of the conventional drugs.